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SCIENCE

FRIDAY, JULY 6, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FROM the point of view of scientific work the New York meeting of the Association was the most successful in its history, with the possible exception of the anniversary meeting held two years ago at Boston. It was not expected that New York City would be a favorable place to awaken local enthusiasm or altogether suitable for social gatherings, but even in these respects there were no grounds for complaint. The attendance—a registration of about 450—was not as large as had been hoped for. It included, however, an unusually large proportion of fellows, and there were perhaps three hundred members of the affiliated Societies present who did not register as members of the Association. The assembly of scientific men was therefore about as large as it ever has been, and considerably larger than since 1884, with the exception of the anniversary meeting.

The general conduct of the meeting met with the approval of nearly all the members, though a few regretted the lack of eleemosynary entertainments and excursions. The members were welcomed to Columbia University by President Low and to the American Museum of Natural History by President Jesup. The address of the president, Professor Woodward, who presided with admirable dignity and tact, is printed below, while last week we were able to publish the address of Mr. Gilbert, the retiring president, which was a model of what such an address should be. Scientific excursions were made to the Botanical Gardens, to the Zoological Park, to the American Museum, to the Marine Laboratory at Coldspring Harbor and elsewhere, but the special feature of the meeting was the number and importance of the papers presented before the sections and affiliated societies.

The scientific pre-eminence of the meeting was due to these special scientific societies holding sessions in conjunction with the Association. The American Chemical Society always has a large attendance and crowded program. It was the first society to become definitely affiliated with the Association, and the result has been to make chemistry the leading science at the meetings. The Botanical Society of America, The Society for the Promotion of Agricultural Science and the American Forestry Association have given botany a place next to chemistry. But this year, for the first time since the beginning of the movement toward special societies, chemistry and botany were rivalled by the work of sections A and B. The American Mathematical Society and the Astronomical and Astrophysical Society of America met with the section for mathematics and astronomy and the American Physical Society with the section for physics, and these sections held meetings of unusual importance. The Geological Society of America strengthens Section E, but unfortunately for the Association the most active geologists are likely to be in the field at the time of the meeting. The work of the Zoological section was unusually good this year. The Association of Economic Entomologists and the American Microscopical Society met with the Association, but the American Morphological Society and the American Ornithologists Union have not hitherto co-operated. Anthropology was strengthened, though only to a limited extent, by the American Psychological Association and the American Folk-lore Society. There were no special societies meeting in conjunction with Section D, Mechanical Science and Engineering, or with Section I, Social and Economic Science, and these are the two weakest sections of the Association. The Society for the Promotion of Engineering Education, which met after the adjournment of the Association, should join with Section D, and every effort should be made to secure the co-operation of the great engineering societies. In like manner the national societies devoted to social and economic science should be persuaded to meet with Section I, and perhaps special societies should be formed relating to the scientific aspects of commerce and education. There is no question that the special societies are strengthening the Association, the only drawback being that many of the members do not join the parent body. As they take advantage of the reduced railway rates and other arrangements for the meetings there is every reason for them to defray their share of the cost. Indeed it is obviously the duty of all men of science to support the historic and general association, whose influence is proportionate to its membership.

Although the annual dues are very moderate — only $3, while they are $5 in the British and French Associations—many members of other scientific societies think that they do not receive an adequate return for membership. It is a fact that owing to the wide dispersion of men of science in America and the difficulties of long journeys in mid-summer fewer than one fourth of the members attend the meetings. There is consequently hesitation in joining the Association and a tendency to let membership lapse. The Association, however, took action at the recent meeting that will give even to those who are unable to attend the meetings a definite and adequate return for membership. The Council unanimously decided to send SCIENCE free of charge to all members of the Association next year and to publish in it official notices and proceedings. This action will increase the membership of the Association and the interest of the members in its work, while at the same time extending the influence of this JOURNAL, and promoting the cause to which both the Association and the JOURNAL are devoted—the advancement and diffusion of science.

The Association took another important step in establishing a section of physiology and experimental medicine. Since the foundation of the Association and even since the division into sections eighteen years ago a group of sciences has developed with remarkable activity. Physiology, experimental psychology, anatomy, embryology, histology, morphology, pathology, bacteriology and their applications have hitherto been ignored by the Association. Yet they represent one-half of the work of the German Association. An increase in membership and a new impetus will undoubtedly follow the recognition of sciences whose great advances and beneficent influences are seen on all sides.

The lengthening of the term of service of the treasurer to five years was the only other amendment made to the constitution. This was an obvious improvement, the treasurer being as a matter of fact a permanent officer, though he has hitherto been elected from year to year. Several important recommendations were made by the Council, an account of which will be found in the report of the general secretary published below.

It is a cause for congratulation that the permanent funds of the Association were increased last year by over forty per cent. Mr. Emerson McMillin's qualification as a patron provided $1000, and the permanent secretary was able to hand over to the treasurer $1500, of which $500 resulted from the falling in of the dues of life members, and $1000 represented savings due chiefly to the efficiency of the permanent secretary. He was able to add a further sum of $1000 at the present meeting. In spite of this increase, certainly great when recorded as a percentage of the accumulation of many years, the permanent funds are lamentably small. Only when 100 patrons, each contributing $1000, have been secured will the Association be able to make appropriations for research equal to those of the British and French Associations.

The small amount available, the interest on the permanent funds amounting to $233, was used in the way most likely to produce valuable results and strengthen the Association. It was divided among four committees, to be spent under their auspices in special researches. The committees are: on anthropometry; on the quantitative study of biological variations; on the cave fauna of North America, and on the relation of plants to climate. When it is generally known that the small sum of $50 a year will provide for a research under the auspices of a committee of the Association it seems certain that the money needed will be forthcoming.

In accordance with a good departure the general committee at Columbus, in selecting New York as the place of meeting for the present year, recommended Denver for next year, and this recommendation was unanimously adopted. Invitations of great cordiality were presented, and it was the general opinion that an 'American' Association should meet farther to the west than hitherto. A good meeting at Denver is certain, while at the same time the influence of the Association will be exerted in a region where educational and scientific institutions are making extraordinary advances. Pittsburg was recommended as the place of meeting in 1902. The president was elected by a unanimous vote of the general committee. It was the opinion of all that no one so well deserved this honor as Professor Charles Sedgwick Minot, of the Harvard Medical School, eminent in the great group of sciences now first recognized by the Association, as well as in his labors on behalf of the Association.

PROCEEDINGS OF THE ASSOCIATION.

The forty-ninth annual meeting of the American Association for the Advancement of Science began with the meeting of the Council at the Hotel Majestic at noon on Saturday, June 23d, and the first general session of the members was held at Columbia University at 11 o'clock on Monday, June 25th. The meeting was called to order by the retiring president, Mr. G. K. Gilbert, of the U. S. Geological Survey, who introduced the president-elect, Professor R. S. Woodward, of Columbia University. President Low welcomed the Association to New York City and to Columbia University and Professor Woodward replied. These addresses are published in this number of Science. Governor Roosevelt having telegraphed that he was unable to be present owing to important engagements, the Hon. James Wilson, Secretary of Agriculture, was called upon, and made an address emphasizing the importance of applied science, to which the Department of Agriculture is contributing so much.

On the adjournment of the general session, the sections organized and in the afternoon the addresses of the vice-presidents were given. There were only five of these, the addresses by Mr. J. A. Brashear, Professor C. B. Davenport, Mr. A. W. Butler and Professor C. M. Woodward having been postponed until next year in accordance with the plan that will hereafter be followed of having the addresses given by the retiring, instead of by the incoming vice-presidents. The addresses given at New York, now in course of publication in this Journal, are as follows:

Section of Mathematics and Astronomy: 'The Teaching of Astronomy in the United States,' by Professor Asaph Hall, Jr.

Section of Physics: 'The Kathode Rays and some related Phenomena,' by Professor Ernest Merritt.

Section of Chemistry: 'The Eighth Group of the Periodic System and some of its Problems,' by Professor Jas. Lewis Howe.

Section of Botany: 'Some Twentieth Century Problems,' by Professor William Trelease.

Section of Geology: 'Precambrian Sediments in the Adirondacks,' by Professor J. F. Kemp.

On Tuesday evening the members of the Association were welcomed to the American Museum of Natural History by President Jesup, and Mr. Gilbert gave the address on 'Rhythms and Geologic Time' published in the last number of this Journal.

The scientific work of the meeting was presented before the nine sections of the Association and the fifteen affiliated societies meeting with it, and will be reported fully in subsequent issues of this Journal.

The number of members and fellows in attendance at the time of the last general session was 447, which during the day was probably increased to slightly over 450. Different sections of thé country were represented as follows: New York by 184 members; District of Columbia, 47; Massachusetts, 46; Pennsylvania, 32; Ohio, 22; New Jersey, 17; Indiana, 13; Connecticut, 12; Wisconsin, 10; Michigan, 9; Illinois, 8; Rhode Island, 7; Maryland, 6; New Hampshire, 5; Virginia, 4; three each from Canada, Missouri and North Carolina; two each from Iowa, Kentucky, West Virginia, Maine, Mississippi, Florida, Minnesota and Colorado; one each from Alabama, Tennessee, Kansas, Louisiana, South Dakota, California, Texas, Nebraska, Delaware and South Carolina.

Two hundred and fifty-nine new members were elected at the meeting, which, including those elected at previous meetings of the Council, makes a total of 331 new members since the Columbus meeting. It was announced by the Permanent Secretary at the close of the meeting that the membership list numbers 1900.

Seventy-seven fellows were elected as follows:

H. C. Lord, Ohio State University, Columbus, O.

E. S. Crawley, University of Pa., Philadelphia.

George A. Hill, U. S. Naval Observatory, Washington, D. C.

William J. Humphreys, Charlottesville, Va.

Miss Mary W. Whitney, Vassar Observatory, Poughkeepsie, N. Y.

Paul S. Yendell, Dorchester, Mass.

Arthur L. Foley, Indiana University, Bloomington, Ind.

Oscar M. Stewart, Cornell University, Ithaca, N. Y.

Barry McNutt, Lehigh University, South Bethlehem, Pa.

C. E. Mendenhall, Williams College, Williamstown, Mass.

Chas. F. Cox, Grand Central Station, New York, N. Y.

John F. Mohler, Dickinson College, Carlisle, Pa.

D. B. Brace, University of Nebraska, Lincoln, Nebr.

Wallace C. Sabine, Harvard University, Cambridge, Mass.

Chas. F. Scott, Westinghouse Co., Pittsburg, Pa.

Chas. T. Knipp, University of Indiana, Bloomington, Ind.

Chas. A. Perkins, University of Tennessee, Knoxville, Tenn.

A. DeF. Palmer, Brown University, Providence, R. I.

Frank A. Wolff, Jr., Columbian University, Washington, D. C.

George F. Stradling, Central High School, Philadelphia, Pa.

James S. Stevens, University of Maine, Orono, Maine.

R. W. Wood, University of Wisconsin, Madison, Wis.

Augustus Strowbridge, University of Michigan, Ann Arbor, Mich.

C. E. St. John, Oberlin College, Oberlin, Ohio.

Herschel C. Parker, Columbia University, New York, N. Y.

Thomas Clarke, Chapel Hill, N. C.

Miss Mary E. Pennington, Woman's Medical College, Philadelphia, Pa.

W. R. Whitney, Mass. Inst. Tech., Boston, Mass.

M. T. Bogert, Columbia University, New York, N. Y.

E. C. Franklin, Kansas State University, Lawrence, Kansas.

J. B. Weems, Iowa Agr. College, Ames, Iowa.

Samuel Bookman, Pathological Institute, New York, N. Y.

C. W. Moulton, Vassar College, Poughkeepsie, N. Y.

J. A. Deghuee, Brooklyn, N. Y.

A. W. Smith, Case School, Cleveland, Ohio.

C. W. Dabney, University of Tennessee, Knoxville, Tenn.

A. P. Saunders, Hamilton College, Madison, N. Y.

F. A. Genth, Lansdowne, Pa.

A. J. Hopkins, Amherst College, Amherst, Mass.

L. H. Orleman, Military Academy, Peekskill, N. Y.

W. O. Crosby, Mass. Inst. Tech., Boston, Mass.

F. P. Gulliver, St. Marks School, Southboro, Mass.

J. V. Lewis, Clemson College, S. C.

Edward Orton, Jr., Ohio State Univ., Columbus, Ohio.

W. G. Tight, Granville, Ohio.

S. Prentiss Baldwin, Cleveland, Ohio.

G. H. Barton, Cambridge, Mass.

S. W. Beyer, Iowa Agric. College, Ames, Iowa.

A. P. Brigham, Hamilton, Madison Co., N. Y.

H. C. Bumpus, Brown University, Providence, R. I.

Mrs. S. H. Gage, Cornell Univ., Ithaca, N. Y.

W. H. Welch, Medical School, Johns Hopkins Univ., Baltimore, Md.

Dean C. Worcester, U. S. Commissioner, Manila, P. I.

C. Hart Merriam, Dept. Agric., Washington, D. C.

E. B. Wilson, Columbia Univ., New York, N. Y.

G. S. Hopkins, Cornell University, Ithaca, N. Y.

Outram Bangs, Boston, Mass.

Frank Smith, Univ. of Illinois, Urbana, Ill.

A. G. Mayer, Museum Brooklyn Institute, Brooklyn, N. Y.

L Schoney, New York, N. Y.

C. L. Edwards, Trinity College, Hartford, Conn.

W. F. Ganong, Smith College, Northampton, Mass.

Wm. L. Bryan, Indiana Univ., Bloomington, Ind.

G. G. MacCurdy, Yale Univ., New Haven, Conn.

J. Walter Fewkes, Bureau of Ethnology, Washington D. C.

A. F. A. King, Washington, D. C.

F. R. Rutter, Dept. Agric., Washington, D. C.

George A. Hoadley, Swarthmore College, Swarthmore, Pa.

W. M. Stine, Swarthmore College, Swarthmore, Pa.

H. J. Webber, Dept. Agr., Washington, D. C.
Frank Wm. Rane, Agricultural College, Durham, N. H.
S. A. Beach, Agl. Exp. Station, Geneva, N. Y.
B. M. Duggar, Cornell University, Ithaca, N. Y.
A. D. Selby, Agl. Exp. Station, Wooster, Ohio.
Grace E. Cooley, Ph.D., Wellesley, Mass.
Oscar Loew, U. S. Dept. Agr., Washington, D. C.
John Muir, Martinez, Cal.

The more important transactions of the Council are the following:

A committee was appointed consisting of Professor Simon Newcomb, Mr. G. K. Gilbert, Professor R. S. Woodward, Professor Jas. Lewis Howe and Dr. L. O. Howard, to report upon the relations of the Association and the journal SCIENCE, and drew up the following resolution, which was unanimously adopted by the Council:

That the Council accept the proposal of The Macmillan Company to furnish the journal SCIENCE to all members of the American Association in good standing, at the rate of two dollars per year each; to take effect for one year from January 1, 1901, the total amount of the subscription at this rate to be paid by the permanent secretary from funds in his hands, and the members to receive the journal free of charge to themselves on the following conditions: That to the words of the title of the journal be added the words, 'Publishing the official notices and proceedings of the American Association for the Advancement of Science,' and that the price to all non-members of the American Association for the Advancement of Science be maintained at five dollars per annum.

That the President of the Association, the Permanent Secretary and one other member to be appointed by the chair be a committee with power to arrange details with The Macmillan Company.

The Committee composed of G. K. Gilbert, R. S. Woodward, F. W. Putnam, J. McK. Cattell and L. O. Howard, appointed at the April meeting of the council to consider the organization of an American branch of the International Association for the Advancement of Science, Arts and Education reported as follows:

That the Committee approves the idea of international co-operation in the field of science and recommends that the council designate a delegate to a national conference looking to that end.

The Committee on the disposal of back volumes of proceedings, consisting of G. K. Gilbert, L. O. Howard and T. H. Norton, reported as follows:

Your committee appointed at the New Haven meeting to consider the disposal of accumulated back numbers of proceedings, having given the matter due consideration, report the following recommendations:

1. That the back volumes now in storage in Cambridge be transported to New York and stored in the Columbia University at no storage cost to the Association.

2. That 50 complete sets be reserved for sale only in sets at 50 cents per volume.

3. That other back volumes, not less than five years old be sold to members for 50 cents each.

4. That volumes published within five years be sold at $1.50 each with the usual trade discount of 25 per cent.

The Library Committee reported and two of the members, Drs. T. H. Norton and Alfred Sprenger, resigned. A committee on the disposition of the Association library was appointed, consisting of W J McGee, B. F. Thomas and L. O. Howard.

A committee, consisting of John M. Clarke, W J McGee, J. McK. Cattell, Chas. H. Hitchcock and Theo. Gill was appointed to report on the erection of a bronze tablet to mark the house in Albany where the geologists of New York in 1838 met to make arrangements for the Association of American Geologists, the parent-body of the American Association for the Advancement of Science.

The committee of Section H, on the teaching of anthropology, was made a standing committee of the Association. It consists of W J McGee, G. G. McCurdy, Frank Russell, Franz Boas and W. H. Holmes.

Dr. Thomas Wilson reported progress on behalf of the Committee appointed to obtain legislation looking to the protection and preservation of many articles of archæological, ethnological and anthropological interest and value.

The action of the American Chemical

Society strongly recommending the establishment of a National Standardizing Bureau in Washington by the government was endorsed.

At the request of Section G, the following was adopted :

Resolved, That the American Association for the Advancement of Science, recognizing the importance of the preservation in its original condition of some portion of the hard-wood forests of the Southern Appalachian region, respectfully petitions Congress to provide for the establishment in that region of a National Forest Reserve.

The action of the same section in adopting the resolution given below was approved :

WHEREAS, the Pacific Coast redwood forests (*Seqoia Sempervirens*) are now practically all in the hands of private owners, who hold them for lumbering purposes ; and

WHEREAS, this species occupies a certain coast-range belt of remarkable climatic characteristics, the study of which ought to be of profound interest to science ; and

WHEREAS, the only other living *Seqoia* (usually known as *Sequoia gigantea*) which the redwood rivals in its proportions as well as in its interest to travellers and to men of science, has already received protection in part from the United States, by the establishment of the Sequoia National Park and the General Grant National Park, in the Sierra Nevadas ;

Resolved, that the Botanical Section of the American Association for the Advancement of Science strongly approves the recent efforts of the several societies, clubs, colleges, universities and private citizens in California to create a public opinion that will result in the purchase and permanent preservation as a public forest park, of a tract of over 25,000 acres, largely made up of the primeval redwood forest, situated in the Santa Cruz mountains, forty miles southeast of San Francisco and fifteen miles south of the Leland Stanford Jr. University.

The reports of those to whom grants for research were made at the Columbus meeting, approved by the proper sections and accepted by the Council, were as follows :

REPORT OF THE COMMITTEE ON THE STUDY OF THE WHITE RACE IN AMERICA.

The Committee on the study of the white race in America report that in accordance with the plans proposed at the Columbus meeting they have made arrangements to carry out physical and mental tests on members of the Association at the present meeting, and these are now being made. A report on this work and on work of an anthropometric character done under the auspices of this committee and elsewhere has been made to Section H at its Christmas meeting and at the present meeting, and it need here only be remarked that the measurements of our members will be of special interest when compared with those of members of the British Association. In view of the fact that instruments were at hand at the place of meeting this year it was not necessary to purchase them, but if the work is continued it will be necessary to secure a set of instruments that will be the property of this Association and can be sent from place to place. We ask for this purpose an appropriation of $50 to be added to the similar appropriation made last year. We ask that the name of the Committee be changed to Anthropometric Committee, thus limiting and defining more exactly its scope. We ask that the vacancy on the Committee caused by the death of Dr. Brinton be filled by the appointment of Professor Joseph Jastrow.

J. MCK. CATTELL.
F. BOAS.
W J MCGEE.

REPORT OF THE COMMITTEE ON THE QUANTITATIVE STUDY OF BIOLOGICAL VARIATION.

The Committee has held two meetings. The first took place at New Haven during the Christmas recess, Drs. Boas, Cattell and Minot being present. At this meeting it was planned to prepare a report on the course of study which should be pursued in preparation for quantitative work in variation, and on the instruction now given in variation in colleges. It was proposed also to present a report on the history of the development of the quantitative study of variation. This report has been prepared by the recorder and read before Section F. The second meeting of the Committee was held at the Hotel Majestic, New York, June 25, 1900. Present, Drs. Cattell, Eigenmann and Davenport. At this meeting a summary of the results got by Mr. C. C. Adams, to whom the grant of $50 was made, was received. The full report of Mr. Adams is to be presented to Section F. As Mr. Adams has not yet completed his studies it was voted : To recommend that, if possible, one hundred dollars be appropriated to the Committee on the Quantitative Study of variation to aid Mr. C. C. Adams in his further researches on the variation of the genus Io. In case it is not feasible to appropriate so large a sum the Committee recommends that so much as possible be granted.

The Committee asks to be continued.

F. Boas,
C. S. Minot,
J. McK. Cattell,
C. H. Eigenmann,
C. B. Davenport, *Recorder.*

REPORT ON THE INVESTIGATION OF THE BLIND VERTEBRATE FAUNA OF NORTH AMERICA.

In the absence of a committee I beg leave to make the following personal report on the grant of $100 made me for investigation of the blind vertebrate fauna of North America.

1. Collections of typhlogobins were made at the foot of Point Loma, Cal.

2. A collection of 12 Rhineura was secured through dealers.

3. Mr. E. B. Forbes visited southwestern Illinois and secured a series of chologasters at what I had supposed to be their breeding time.

4. Six trips were made to Mitchell, Indiana, caves to secure embryological material.

5. One trip was made to the Mammoth Cave region in Kentucky.

6. A visit was made to the San Marcos, Texas, wells and caves.

7. In most cases the railroad companies granted either passes or half rates to the points mentioned. The total expenses of these trips chargeable to the appropriation were $139.66. An appeal was made to the Trustees of the Indiana University to pay as liberal an amount of these expenses as possible. An appropriation, the amount of which I have not yet ascertained has been granted by them so that a balance of the Association grant is still available.

The results obtained during the year were embodied in the paper presented during the meeting of of Section F on June 26th.

To assist in the continuation of the work in hand I will recommend that a committee be appointed to direct the work. I hope that a small additional grant be made for the use of the committee during the year.

C. H. Eigenmann.

The Committee on Grants made the following recommendations to the Council and they were adopted:

1. That a grant of $50 be made to the Committee on anthropometry.

2. That a grant of $50 be made to the Committee on the study of blind vertebrates.

3. That a grant of $100 be made to the Committee on the quantitative study of biological variations.

4. That a committee be appointed to study the relation of plants to climate, and that a grant of $33 be made to such committee.

5. That if practicable an allotment of $17 be made to the last named committee from the funds in the hands of the permanent secretary.

The two new committees to which grants were made were appointed as follows:

'On the Study of Blind Vertebrates': Theodore Gill, *Chairman*; A. S. Packard, S. H. Gage, C. O. Whitman, H. C. Bumpus, C. H. Eigenmann, *Secretary.*

'On the Relations of Plants to Climate': W. M. Trelease, D. T. McDougal, J. M. Coulter.

The Treasurer in his report for the year ending December 31, 1900, showed that the permanent funds in his hands at the beginning of the year were about $6083, which were increased during the year by about $2733, making the total about $8817. The receipts represented $1000 from Mr. Emerson McMillin as patron, $500 from fees of deceased life members, $1000 in addition from the permanent secretary and about $233 interest. The permanent secretary in his financial report showed a balance from his preceding account of $3723.90 and a balance carried forward to the new account of $4228.33. The receipts were $6216 from members and $172.49 from miscellaneous sources. The expenditures in addition to the $1500 handed over to Treasurer were: Publications, part of Boston volume, $1003.33; Expenses, Columbus Meeting, $427.54; General Office expenses, including expressage and postage on Proceedings, $931.19; Salaries, $1970; Miscellaneous disbursements, $52.

The general session met daily. It passed resolutions in memory of Dr. Edward Orton, who died during his term of office as president, and adopted amendments to the constitution establishing a Section of Physiology and Experimental Medicine and extending the term of office of the treasurer to five years. Amendments to the Constitution, which lie over until next year, were proposed, making the presidents and secretaries of the affiliated societies members of the Council, establishing a section of Commerce and Manufactures, and giving the Council, under certain conditions, power to change the place and time of meeting.

At the last general session it was announced that the general committee had elected officers for next year as follows:

President.

Professor Charles Sedgwick Minot, Harvard Medical School.

Vice-Presidents.

Mathematics and Astronomy: Professor James McMahon, Cornell University.

Physics: Professor D. D. Brace, University of Nebraska.

Chemistry: Professor John H. Long, Northwestern University.

Mechanical Science and Engineering: Professor H. S. Jacoby, Cornell University.

Geology and Geography: Professor C. R. Van Hise, University of Wisconsin.

Zoology: President D. S. Jordan, Leland Stanford Jr. University.

Botany: B. T. Galloway, U. S. Department of Agriculture, Washington, D. C.

Anthropology: J. W. Fewkes, Bureau of Ethnology, Washington, D. C.

Economic Science and Statistics; John Hyde, Department of Agriculture, Washington, D. C.

Permanent Secretary.

L. O. Howard, U. S. Department of Agriculture, Washington, D. C.

General Secretary.

Professor William Hallock, Columbia University, New York.

Secretary of the Council.

D. T. McDougal, New York Botanical Gardens.

Secretaries of the Sections.

Mathematical and Astronomy: Professor H. C. Lord, Ohio State University.

Physics: J. O. Reed, University of Michigan.

Chemistry: Professor W. McPherson, Ohio State University.

Mechanical Science and Engineering: William H. Jacques, Boston, Mass.

Geology and Geography: Dr. R. A. F. Penrose, Pierce, Arizona.

Zoology: Professor H. B. Ward, University of Nebraska.

Botany: A. S. Hitchcock, Manhattan, Kansas.

Anthropology: G. G. McCurdy, Yale University.

Economic Science and Statistics: Miss C. A. Benneson, Cambridge, Mass.

Treasurer.

Professor R. S. Woodward, Columbia University.

Denver was selected as the place of meeting for next year, and Pittsburg was recommended for 1892. The meeting next year will begin with the session of the council on Saturday, August 24th, and the scientific work will begin on Monday, August 26th.

CHARLES BASKERVILLE,
General Secretary.

ADDRESS OF WELCOME.

PRESIDENT LOW, of Columbia University, said: Mr. President and Members of the American Association for the Advancement of Science: It gives me very much pleasure to welcome this Association to the City of New York and to Columbia University. It is thirteen years since this Association met in the City of New York, although it met I believe in 1894 in the City of Brooklyn which has since become a part of this city. In that interval of thirteen years there has been a profound stirring of the scientific spirit in this vast community. Witness, if you please, the foundation of the Botanical Garden of New York by the co-operation of the City and of private organizations, after the pattern which has shown itself so effective in the case of the Metropolitan Museum of Art and of the American Museum of Natural History. Witness again, the formation of the New York Zoological Garden which is projected upon a scale entirely worthy of this great metropolis; witness the establishment by the City authorities of the Aquarium; witness the enlargement, until it is three-fold its size of thirteen years ago, of the American Museum of Natural History; all of these things being done either by the City itself as in the case of the Aquarium, or by the City in co-operation with private agencies as in all the other cases. The Universities of the City have made immense strides in the direction of scientific equipment in the same interval. Our own University, New York University and the Medical Schools attached to these two universities and to Cornell University and to the Long Island Medical College, all of them only thirteen years ago practically without laboratory equipment, all of them to-day equipped in a way to compare favorably with medical schools in any part of the country and in some respects, perhaps, favorably with medical schools in any part of the world. The scientific societies of New York have also awakened to new life. All these things show that throughout the length and breadth of this vast community a remarkable stirring of the scientific spirit has occurred since your last meeting here. It may easily be that your meeting here at that time sowed the seeds, or some of the seeds at least, which have produced this valuable and welcome fruit. I congratulate you upon securing for the advancement of science such an ally as this metropolitan city. It has indeed the strength of a giant, and, once aroused, it brings to any cause to which it allies itself a giant's strength. Therefore, I congratulate you, as I have said, in obtaining for the cause which appeals to you so important an ally as the City of New York.

I think I may also say that this University, which to-day welcomes you as its guest, has had its fair share in the reawakening. In 1887, when you were here, my predecessor, the late Rev. Dr. Barnard, was president of this University; when he died, a year or two later, it was found that he had left his entire estate to the University, subject to a life interest on the part of his widow, with the provision that $10,000 should be set apart for the maintenance of a Barnard fellowship in science, to be awarded to some fellow who should pursue physical and chemical research. He provided also for the award, every five years, of the 'Barnard medal for meritorious service to science.' This medal is awarded by the Trustees of the University upon the recommendation of the National Academy of Sciences. It was given this month to Professor Roentgen for the discovery of the X-rays. The remainder of Dr. Barnard's estate, he provided, should be a fund for the increase of the Library, the income of which should be used especially for the purchase of scientific books, and more especially in the domain of physics and of chemistry. When Mrs. Barnard died, a year or two later, it was found that she had added her own estate to that of her husband and dedicated it to the same purposes. I think it is interesting to find that our late president should have had the cause of science so near at heart, for he was, as many of you know, a clergyman of the Episcopal Church; but he was one of those who saw no contradistinction between the Truth of God written in the manuscripts of Nature, and the Truth of God as revealed through the Scriptures. In that respect he was a worthy representative of the University whose motto has been, since its foundation in 1754, "In Thy light we shall see light." Therefore we anticipate new discoveries in science, because at the center of all things, we believe, is the Father of Light. In 1887 this University studied science and taught science. It had not, however, committed itself to the advancement of science, as in the interval it has done, by the establishment of its Faculty of Pure Science. I remember that when Professor Osborn was invited to the chair of biology, in this University, he told me that only a few years before he had wanted to study that science in the City of New York, and could find no opportunity. There was then no provision, either public or private, for the study of biology in this great metropolis. You know as well as I how great is the change to-day.

Any cause which is sufficiently great to attract delegates from all over the United States every one recognizes as a cause of importance. The fact that, from so wide a territory, men and women will come together to discuss that interest stamps it as an interest of unusual importance. This meeting lacks no element of importance in that regard. Not only does the Association for the Advancement of Science gather its representatives from all parts of the Union, but there are also meeting with you this week at least fifteen affiliated societies; and I believe all of them are national in their scope. But after all, this meeting interests me, less because of the wide range of territory from which it gathers its adherents than from the vast range covered by its interests. Here are men and women whose itnerests reach out through the entire universe. Occupied space, so far as its occupancy can be made known either by photography or by the spectroscope, is included naturally within the range of your interest. On the other hand, you deal with the little things of the universe as carefully as with the great things. Here are those who are interested in all life, whether human or of any other kind. Here are those who are interested in inanimate objects, whether great or small. The interests which you have come to serve are not national in their scope only, nor international, nor worldwide—they are universal; and it seems to me that this fact itself is an interesting illustration of the unity of Nature. No one can study any part of the natural universe without being drawn into the current with those who are studying the universe in some other part.

But I should fail, it seems to me, to do justice to your Association if I did not as President of this University, recognize the immense contributions of science to the cause of education. I suppose there is hardly a lecture room in this building in which preparation is not made for the use of the electric lamp, so that through the use of electricity and photography almost every branch of scientific research is being forwarded. The student can sit in his room, and see whatever the sun sees; he can see what the sun never saw, because the sun is blinded by the fullness of its own light; he can see what exists in the outer universe and also in the depths of the earth. But this is not the greatest contribution science has made to education. After all, it is, in all these things, the unseen rather than the seen that is the essential. I should say that science has contributed to education in the last half century two things vastly more important than all its contributions to the better equipment of the class room. It has given to us the evolutionary theory; which, being applied in almost every domain of study, has revolutionized it; and it has given to us, also, the scientific method. I stated to you that thirteen years ago there was hardly a laboratory in the City of New York in connection with an educational institution. There were chemical laboratories and assay laboratories, here and there, but almost no others. Even the public schools of the City are equipped with laboratories in several sciences at the present time. So that in those two gifts—the evolutionary theory and the scientific method, you have made contributions which certainly demand the most generous recognition on the part of educators. In making this statement I am sure that I speak, not only for this University, but for every university in the land.

I am especially glad to welcome you because you are an Association for the *Advancement* of Science. That, after all, is what ought to make you feel at home in the atmosphere of this University; for a university that does not assist the advancement of science has hardly a right to call itself by that great name. I heard Phillips Brooks say, in a sermon that I heard him preach in Boston when this Association met there 20 years ago, that you can get no idea of eternity, by adding century to century or by piling æon upon æon ; but that, if you will remember how little you knew when you sat at your mother's knee to learn the alphabet, and how with every acquisition of knowledge which has marked the intervening years you have come to feel, not how much more you know but how much more there is to be known, all can get some idea of how long eternity can be, because all can understand that there never can be time enough to enable any one to learn all that there is to know. There is so much to be known, that even the great advances of the last generation do not make us feel that everything is discovered, but they appeal to new aspirations and awaken renewed energy in order to make fresh discoveries in a region that teems with so much that is worthy of knowledge. I congratulate you upon your success, and I bid you welcome to Columbia.

ADDRESS OF THE PRESIDENT.

Professor Woodward said : Under the favorable auspices of this institution of learning, with its commodious quarters and its scientific atmosphere so generously placed at our disposal, we meet to-day to begin the forty-ninth session of the American Association for the Advancement of Science.

The life of this Association has been contemporaneous with an epoch of triumphant scientific progress ; and in this last year of the century one is tempted to look back into the history of the achievements of our predecessors, in order to render them due homage, and in order to learn from their experience the wisdom essential for future guidance. One is prone especially to recall the noble lives and the indefatigable industry of the founders and early workers of this Association, who are no longer with us, but whose careers are sources of admiration and inspiration to the present generation of scientific men in America. There were Rogers and Henry and Bache, and Agassiz and Peirce and Dana, and Torrey and Hall and Lea, and Barnard and Gould and Gray, and Marsh and Dawson and Newton, and Brinton and Cope ; and many others not less worthy, whose life work was intimately related to the work of this Association. The mere mention of a few of these honored names may suffice, however, on this occasion, to remind us of our indebtedness to them, and to assure us of the steady progress which has attended the Association in its growth from a single section of a half century ago to the nine different sectious and twice as many affiliated societies of to-day. The fertility of the study of our planet in stimulating thought and in leading thought to action is at once apparent when we recall that out of the small beginnings of a few naturalists who styled themselves the American Geological Society have sprung the varied activities of this Association and the kindred societies which meet with us this week. Verily we may say, in the noble words inscribed over the entrance to Schermerhorn Hall on our right, " Speak to the earth and it shall teach thee."

But science knows no nationality, and the forward movement in which our Association is engaged is only a part of a world wide advance which is undoubtedly the most noteworthy characteristic of the civilization of the present half century. And wherein, we may fittingly ask ourselves, and still more fittingly may the general public ask us, does this advance consist? What, in common parlance, are the contributions which the science of our day has brought to the betterment of man's estate ? In a summary way, disregarding material benefits, which everybody recognizes, these contributions may be specified under three heads in the order of their historical succession.

First, there is the far-reaching generalization known as the law of conservation of energy, whose establishment dates from about 1850. This law holds in what for the present we find it convenient to call the material world. It enables us to describe what goes on in that world in the simplest terms and in the most comprehensive fashion. It relates unknown to known phenomena; and it enables us to predict with practical certainty not only the feasibility and efficiency of the vast aggregate of mechanical appliances on which the continuity of daily life now depends, but also the range and limitations of the physical processes of the entire visible universe. This doctrine supplies at once the principal criteria of, and the principal methods of investigation in, physical science. It is the most precise and the most comprehensive of theories devised by man.

Secondly, there is the doctrine of evolution, which dates substantially from the publication of Darwin's work on the Origin of Species in 1859. This, like the doctrine of energy in the material world, enables us to describe in the simplest terms and in the most comprehensive fashion the succession of events in what for the present we find it convenient to call the organic world. It enables us to trace the lines of development along which life has proceeded from age to age in geologic time, and to predict with some degree of probability the course and order of development in the future. It enables us to see how in the endless interactions of the organic and inorganic worlds, the former is adapted to the latter and the latter is moulded by the former; so that the history of terrestrial life, with its teeming forms of animal and vegetable organisms, becomes, in the light of this doctrine, at once readable and verifiable. But the law of evolution is not limited in its application to the lower forms of life alone. It extends to man as well, and proclaims him a part of, and not apart from, the world of phenomena we seek by scientific methods to explain. Thus, with the advent of this doctrine, the anthropocentric theory of the universe, so long held by man, vanishes; but by way of compensation, if any were needed, the new view of his rôle confronts him with the transcendent problem in which the instrument of investigation is, in a far higher degree than hitherto, the object of research.

Thirdly, and perhaps most important of all, there is the educational renaissance which seems to be a direct result of the increase and diffusion of science in our times. Learning is no longer restricted to a narrow range of subjects. Studies are no longer strictly divisible into those which are liberal or humanistic, and into those which, *per contra*, must be illiberal or demoniacal; and the value of knowledge is no longer measured by linguistic standards alone. In short, we have come to understand the essential unity of knowledge and the universality of its sources; and that progress is attained not so much by journeying along the easy highway of *à priori* reasoning as by following up the rough trails of observation and experiment. So rapidly and completely has this renaissance come about that many of the present generation are quite unable to understand how educational affairs could have been at all different in the preceding generation. That liberal provision should be made for the teaching of science in every school, and especially in every college and university, now goes without saying; and munificent endowments for the maintenance of scientific instruction and investigation are everywhere the order of the day. But it was not very long ago—quite within a stretch of the recollection of many here present—when science was an unknown quantity in our common schools and a sort of imaginary quantity in our colleges. The average school boy's idea of science, as Huxley says in one of his earlier essays, was that it meant 'skill in boxing.' One professorship in a college was commonly comprehensive enough to include all the sciences, and frequently too comprehensive for the peace of college faculties; for, strange as it now appears to us, some of the growing sciences were looked upon as threatening the stability of the social fabric, and all were regarded as dangerously aggressive. Laboratories were either wholly wanting or little used; and although most students gained the idea that all that is worth knowing was ascertained long ago and is to be found in books, libraries seemed to be maintained for the sole benefit of librarians and bookbinders. These were the good old times when the college professor heard recitations by day and read polite literature by night.

It is matter of history that the educational progress of the past three decades has not been accomplished without an intellectual struggle, the noise of which is still heard, occasionally, in the wail of those who fear that the treasures as well as the rubbish of the golden age of antiquity may be engulfed by the iconoclasm of the present age of steel. But whatever may have been our prepossessions, as we look back on this struggle, with our senses of proportion and humor not overstrained by the pressing nearness of events, there appears little cause for regret. The emancipation of education from the dominance of classical tradition is seen to be merely an incident in the general advance. Whatsoever is worthy and noble in the ancient learning has acquired new and increasing interest in the light of the growing science of anthropology; and whatsoever is unworthy and ignoble may well wither in the light of modern criticism.

But surprising and gratifying as have been the achievements of science in our day, their most important indication to us is that there is indefinite room for improvement and advancement. While we have witnessed the establishment of the two widest generalizations of science, the doctrine of energy and the doctrine of evolution, we have also witnessed the accumulation of an appalling aggregate of unrelated facts. The proper interpretation of these must lead to simplification and unification, and thence on to additional generalizations. An almost inevitable result of the rapid developments of the past three decades especially is that much that goes by the name of science is quite unscientific. The elementary teaching and the popular exposition of science have fallen, unluckily, into the keeping largely of those who cannot rise above the level of a purely literary view of phenomena. Many of the bare facts of science are so far stranger than fiction that the general public has become somewhat overcredulous, and untrained minds fall an easy prey to the tricks of the magazine romancer or to the schemes of the perpetual motion promoter. Along with the growth of real science there has gone on also a growth of pseudo-science. It is so much easier to accept sensational than to interpret sound scientific literature, so much easier to acquire the form than it is to possess the substance of thought, that the deluded enthusiast and the designing charlatan are not infrequently mistaken by the expectant public for true men of science. There is, therefore, plenty of work before us; and while our principal business is the direct advancement of science, an important, though less agreeable duty, betimes, is the elimination of error and the exposure of fraud.

As we contemplate the future activities

of our Association, one of the interesting and inspiring signs of the times is seen in the increasing number of international conferences for the promotion of art, commerce, education, science, and, above all, peace and good will to men. At the joint meetings held last year by the British and French Associations for the Advancement of Science, steps were taken to form an international organization, which has since been perfected under the name of the International Association for the Advancement of Science, Art and Education. The first meeting of this body will be held during the present summer at the Paris Exposition. May we not entertain the confident hope that, under the influence of such an association, science, which has done so much to enlighten the minds and ameliorate the conditions of men during the nineteenth century, will play a still more beneficent rôle during the twentieth century?

And now, with a cordial invitation to our hosts, the Trustees, the President, and other representatives of this institution of learning, and with a like cordial invitation to the general public as well, to attend the sessions of the various sections of the Association, I declare this meeting formally open for the transaction of its regular business.

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*ON THE TEACHING OF ASTRONOMY IN THE UNITED STATES.**

HAVING to teach Astronomy at the University of Michigan, it has been necessary for me to make inquiries regarding the instruction in this subject given at other universities. I have tried to learn also the character of the work done at the different observatories, from the point of view of the development of students and the encouragement of the spirit of scientific research. Thus I propose to discuss briefly the position taken by our colleges, and observatories also, in the teaching of Astronomy.

Not so very long ago in this country of ours, which is rather new after all, many of the young men educated at the colleges were intended for the ministry. They were trained in Latin, Greek, Hebrew, and a little Natural Philosophy, as it was called, this latter subject including all the known sciences, and being taught by one man. There was almost no laboratory work. At present, whether for good or ill, the rule of the clergymen over our colleges is pretty well broken. The old style college president, usually a clergyman of scholarly tastes and sympathies, who teaches the seniors Moral Philosophy, is becoming rare. His place is being taken by the sharp business man, who in his scholarship corresponds very much to a librarian, having a wide knowledge, but not necessarily an accurate one on any subject.

Of late years the elective system has been introduced, and has been extended very far, so that a degree may represent almost anything, in many cases a good deal of technical and professional work being included. If a large number of students are to go to colleges it is necessary, probably, that the technical studies should be allowed to remain, as many would not have the means to give themselves a liberal education.

Of course, it is hard to discuss in a fair and intelligent way the intrinsic merit of Astronomy or any other study. I believe myself that students who can manage it ought to obtain something of a classical training. But in the case of any given student who elects Latin, for instance, is the subject really chosen for the culture which it gives? I must say that in most cases that I know about I can't tell. Sometimes I think that in college all studies

* Address of the Vice-President and Chairman of Section A—Mathematics and Astronomy—at the New New York Meeting of the American Association for the Advancement of Science.

ought to be elective with the exception of a moderate requirement in English, and that as regards mental discipline and culture one thing is about as good as another, if it is properly taught.

To begin with the elementary Astronomy, it seems to me that it should be taught in the high schools and preparatory schools as well as in the colleges. Preparatory work in it ought to be accepted for admission to college. By elementary Astronomy I mean those common, every-day facts of the science which can be learned by any intelligent student without mathematical training; for example, why the stars rise and set, the motions of the planets and the moon among the stars, the reason for the seasons, the names of the principal constellations and why they seem to change with the seasons. These are things that are before our eyes all the time, and every one who is fairly well educated ought to know something about them. I would not say that this Astronomy ought to be required for entrance to college, or required in college, but it certainly ought to stand on the same plane with Botany, for instance, and Zoology.

As a culture study in college I would bring to your notice also the history of Astronomy. The study of this science no doubt goes back to a time before we have any historical records, and probably was connected with religious worship and festivals. The motions of the sun, moon and planets were watched and studied. It was seen very soon that the seasons and crops and life on the earth depended on the sun's position in the sky. Thus the sun was worshipped as a god, giver of life and harvests. It may be that our Christmas is the remnant of an old pagan festival when rejoicing was had because now the sun would turn and go north and winter would leave the northern hemisphere, and vegetation and life would come back.

Therefore, in the earliest times Astronomy was studied a good deal by the priests. They kept the calendar and the dates of the religious festivals. They followed the motions of the sun, moon and planets, and knew that the planets sometimes advanced and sometimes retrograded in the sky. They had a considerable observational knowledge of the heavens. It is said the Chaldeans had a very exact calendar, better than ours, and giving only an error of one day in ten thousand years. They must therefore have known the length of the tropical year with great exactness.

It would be natural, too, for the sailors of the Mediterranean sea to have considerable practical knowledge of Astronomy. Much commerce was carried on this sea. The Phœnicians voyaged to Britain and Spain and Carthage. The Greeks had many distant settlements. The Romans had large navies, and sailed over all the Mediterranean and to Britain.

But I think one of the most interesting portions of the history of Astronomy would be the philosophical study of the diffferent theories of the universe. Pythagoras is said to have taught the true system of the world, that the earth moves around the sun and at the same time turns on its own axis. But probably this was only one of the doctrines of the speculative Greek philosophers and it was soon abandoned.

It is a curious fact that the system of Ptolemy prevailed for fourteen centuries, and that the new ideas of Copernicus, Galileo and Kepler were so long in being adopted. This may have been because the natural vanity of the human race was appealed to by making the earth the center of the universe. The Ptolemaic theory had come to be supported also by the church, by the old Greek philosophy, and by all the weight of authority. The new theories of Galileo were opposed, no doubt, to the hopes, fears and prejudices held at that time by mankind; his treatment by the church represented these and cannot be charged to any particular church. But it is a strange commentary on the fallibility of human authority and prejudice. Even now most people have little knowledge of the scientific method of experimentation.

As affairs are really conducted it is difficult to secure any readjustment of studies, since so much of practical college politics is involved. First it is necessary to secure a vote of the faculty, then the president appoints a committee, and a majority of the committee divides among itself anything there is in the way of profit. Thus, in the case of some studies a sort of endless chain arrangement has been established, the college requiring the subject for entrance and after entrance, and in that way being enabled to send out a large number of students to teach it. A number of High School teachers of Astronomy have told me that they were not able to obtain money for apparatus because the subject could not be offered for admission to College.

It would seem to me that all who had a long enough training ought to be encouraged to come to College, even though they may not have begun with that idea, but may have intended to stop with the High School. Therefore the number of subjects to be received for admission ought to be a pretty large one, so that the student may use any study that he has taken. The tendency is, I think, in this direction, as well as towards a greater freedom of choice of studies.

Regarding the Astronomy which is somewhat more advanced than the beginning work, as spherical Astronomy and the elements of celestial mechanics, these subjects might be more generally taught than they are at present, both as a part of a liberal education, and looking at them from a commercial point of view. I will explain what I mean by this latter phrase by taking the case of Latin again. For many students Latin is just as much a technical training as that of a bridge engineer. They do not care for it especially, but expect to teach it as soon as they graduate, and earn money, and they are obliged to look at the subject in that light.

Taking, then, what might be called a practical standpoint, some Astronomy is necessary in all surveying and geodetic operations, and a nnmber of engineering schools and colleges offer courses in field work.

Most of the teachers of mathematics and physics in the small colleges are required to give instruction also in astronomy. It would be worth while for them to fit themselves to do this well, both in the use of instruments and in some of the mathematical theory. Also, in this present epoch of the function theory and higher algebra there is a real need of men who are qualified to teach applied mathematics. So many mathematical processes have been invented by the masters for the solution of astronomical questions, especially in differential equations and theoretical mechanics, that every teacher of applied mathematics ought to have some knowledge of astronomy.

Extended instruction in celestial mechanics is offered in few colleges. Not many men can be found who are qualified to teach it, and perhaps it is hardly advisable for the student to go very far unless he has special gifts in that direction. But it certainly requires a much higher order of ability to make advances in celestial mechanics than to execute what are ordinarily called scientific researches, and colleges that have the means ought to provide for the men of this superior ability. I dwell on this somewhat, as the difference is not very clearly understood between ordinary, routine, respectable work, and that which involves some distinct progress. Ability to do the latter is a gift with which a very few men are born, just as there are very few good artists and good poets. Some of the best known and ablest scholars of the world have been those who have made substantial advances in celestial mechanics. I do not see why such men should not be supported and encouraged by the colleges as well as those who study Hebrew, for instance. The working out and discussion of the laws which govern our universe gives strength to a natural theology much more than does the study of Hebrew.

For extended instruction in practical astronomy and observatory work opportunities are now offered at a number of places in this country. Not many years ago it was difficult to obtain it. It was given regularly only at one or two places, and occasionally as a sort of personal favor by a working astronomer. Some twenty years back most of such teaching was done by Professor Stone, now of the University of Virginia. I think it is hardly understood how much he did in this direction, and how many men were once students with him who are now active in the science or have influential positions in the educational world.

The best equipped observatory for teaching purposes that I know of is at Princeton, built, I believe, under the direction of Professor Young. A number of other colleges have observatories, keep them up well, and offer good courses of instruction, both elementary and graduate. In the large astronomical establishments there is a tendency sometimes towards the factory system, which is to be regretted. But where the question is of obtaining the greatest amount of work from a given income, something of the kind may be unavoidable, though when carried too far it tends toward the extinction rather than the extension of research. I have been told that after he became an old man Sir George Airy regretted that he had introduced such a system at Greenwich.

However, at almost all the college observatories that I know of some attention is given to students. It is recognized that it is just as important to train men as to carry on investigations, the German view, and probably the result of so many of our young men going to Germany to study.

With regard to the part that government institutions ought to take in training students and the encouragement of original research, it is difficult to make a criticism. They are often engaged on pieces of heavy work, extending over long intervals of time which private establishments cannot undertake. It may be somewhat necessary to have this done in a routine way, without such regard to whether the computer or assistant is benefited or is making any progress in scholarship. The Naval Observatory is required, for instance, to keep up observations of the sun, moon and planets. However, some arrangement might be made to change assistants about and give them experience in every kind of investigation that is being carried on at any institution. It might be wise to appoint men on very small salaries at first, and allow them half their time for study.

It is interesting to look over the names of the men connected with the American Ephemeris in the early years of its history. I find Davis, Benjamin Peirce, Gould, Newcomb, Hill, Van Vleck, Runkle, Ferrel, and others who became well known in science. I have not had an opportunity to find out how the office was managed.

I have made some examination of the theses in practical astronomy produced in this country, and have attempted to compare them with those presented in Germany and France. On the whole I think we make a creditable showing. Perhaps our instruction is not so thorough and painstaking as that given abroad. There may be with us a tendency to be satisfied with making observations merely, without discussing them properly or attempting to derive the best results. For educational purposes I think too great emphasis cannot be given to the distinction between the two kinds of work I have referred to. That which is planned and carried out in a scientific way alone has value. No matter what skill one may have in observing or making photographs, if he cannot discuss his observations or photographs he stands very much in the relation of a skillful stonecutter to the architect of a building. Very many good photographers can be found in the galleries of our cities, men of great experience and skill, but most of them have no scientific standing and deserve none, though with a little additional experience they could make good astronomical photographs. It is true, also, that many theoretical problems can be solved without having much idea of the theory involved. Orbits are computed by men who do not know very well the meaning of the formulas which they are using. Questions in perturbations are worked out in the same way. Often good and useful results are thus obtained. But this technical skill in using instruments or handling formulas, though necessary, is not a faculty of the highest order. At the same time, however, it ought to be remembered that it is something very useful, and cannot be obtained to a high degree without years of experience.

In practical astronomy I should say that our model ought to be Bessel, that he combined in just the right proportion theoretical knowledge with skill in handling instruments and ability to obtain from an instrument the best results. Especially in relation to college instruction do I think it worth while to call attention to Bessel's papers.

It is true that men of ability will get on without teachers, and that teachers cannot furnish brains. But it is also true that a good teacher can be of very great help even to men of genius. We all have known such, uneducated or self-educated, who would have been helped very much, and been kept from bad blunders if they could have had some training. Encke, Argelander, Gould, Winnecke, Schönfeld, Brünnow, Watson, all studied with experienced astronomers, who are known by their students as well as by their scientific labors. Most of the men just mentioned were teachers, also, and probably left their impress upon the science to as great an extent through their teaching as through their scientific investigations.

It is worth while to take a book like Watson's 'Theoretical Astronomy,' and look over some of the articles, such as the theory of the computation of an elliptic orbit, and the theory of special perturbations, and then examine the treatment given by the different teachers, and see how these theories, after leaving the hands of Gauss, the great master, were modified somewhat by Encke, who was a student with Gauss, and finally by Brünnow and Watson, Brünnow having studied with Encke, and Watson with Brünnow. There is no doubt that Tisserand did a great service to Astronomy by publishing his 'Mécanique Céleste,' putting in a clear and elegant form the principal facts of Mathematical Astronomy, though it is hardly to be ranked with the making of important advances in the science itself.

I think that the standard of scholarship in this country is steadily becoming higher, and that we are having better opportunities for instruction in Astronomy as well as in the other sciences. For however much it may hurt our national vanity, the criticisms of such men as Henry James on our civilization are sound. We are a new country. Our first business has been to clear it up and make roads. We are a nation of business men, trades people. Commercial ideas control, to some extent, our college education, and we lack much that in older countries makes for the advancement of science and art. But time has changed this somewhat, and I think it will change it more.

With regard to all the sciences a large number of misstatements are made regarding their commercial value. Probably Astronomy has been of as much benefit to mankind as any. Every ocean passenger owes to it his safe and rapid passage. Through its help the carriage of every ton of freight is made cheaper. It would be difficult to calculate the money value it has been to the world.

The conception which most people have of the nature of the questions to be solved in Astronomy is a false one. They look on them as text-book problems in mathematics which are arranged to come out nicely. They suppose such questions can be solved definitely and exactly, once for all. They do not know that instruments are imperfect and that observers have personal errors, nor that it is possible to be sure only to a certain limit, personal opinion founded on experience carrying us a little farther, and the rest being uncertain, though methods and instruments and mathematical conceptions may, after a while, be improved. So that in any actual question in practical or theoretical Astronomy it is necessary to deal with facts as they are in nature, and obtain the best possible solution, though perhaps not the one which is exactly true.

Many people, too, and well educated ones, have very curious ideas as to the amount of labor involved in the solution of questions in Astronomy, and as to the progress of the science. An intelligent doctor, who knows that the science of medicine, as far as it is a science, is something of slow growth, who experiments for a year or two on some fairly simple question, cannot understand the same thing in Astronomy, and thinks that it was really founded and developed by some one whom he happens to know about.

In the case of the small observatories, where teaching is expected of the astronomer, the question of economy of time is a difficult one. At Harvard and Johns Hopkins, for instance, six hours of lectures per week would be expected to occupy half of a teacher's time, while in a small establishment one cannot give that proportion and make and reduce observations. At the smaller observatories, too, there is difficulty in requiring proper preparation and in enforcing a high standard of scholarship. Men who believe that the training in law, medicine or engineering should be thorough and severe, because they think the students will be better off commercially, cannot understand that students in Astronomy ought to have the same thorough discipline.

THE EIGHTH GROUP OF THE PERIODIC SYSTEM AND SOME OF ITS PROBLEMS.

II.

We have seen that nearly half a century ago, it was clear to Claus that iron, ruthenium, and osmium belonged in a group together. It was later easily recognized that cobalt, rhodium, and iridium furnished a second triad, while nickel, palladium, and platinum must also be grouped together. The analogies between the three metals of each of these groups is too patent to require discussion, though incidentally we shall have occasion to recur to it. When the elements were arranged in the first periodic tables, these metals did not fall into orderly arrangement; as late as 1878 the atomic weight of osmium was considered greater than that of iridium, platinum, or even gold, while gold was given a weight less than that of iridium or platinum. Cobalt and nickel on one hand and iridium and platinum on the other were considered to have an identical atomic weight. The seeming impossibility of reconciling these nine metals with the periodic law is undoubtedly the reason why they were thrown out in a single group; dumped into a chemical Gehenna as it were, while the rest of the elements were reduced to orderly arrangement. Lothar Meyer, however, saw that there was a possibility that these elements also might be amenable to system, and under his direction Carl Seubert began the revision of the atomic weight of iridium.* This he found to be more than four units less than the figure formerly used, and now the order of these elements appeared to be iridium, gold, platinum, osmium. Three years later Seubert † revised the atomic weight of platinum, finding it lower than that of gold, and this work was confirmed by Halberstadt, ‡ and by Dittmar and McArthur. § The only anomaly in these four metals now was in osmium and this also was resolved by Seubert, ‖ who found that the old value of Berzelius and Frémy was about eight units too high, and that so far from having an atomic weight greater than that of gold, osmium in reality has the lowest atomic weight of the four metals. This revision was justly accounted a great triumph for the periodic law.

As with the other metals, so also much doubt existed as to the atomic weights of rhodium and ruthenium, but the work of Seubert and of Joly, while changing somewhat the older figures, confirmed the order given in Meyer's table. Much work has been done on palladium by Keiser and by Keller and Smith in this country, by Bailey and Lamb and by Joly and Leidié abroad. The figures for platinum and palladium represent a much greater degree of accuracy than those for the other four platinum metals. Indeed it must be said that little accuracy can be claimed for the present figures of rhodium and iridium, and certainly those of ruthenium and osmium cannot be depended on more closely than half a unit.

* Inaug. Diss., Tübingen, 1879.

† *Ber. d. Chem. Ges.*, 14, 865 (1881).

‡ *Ibid.*, 17 (1884), 2962.

§ *J. Soc. Chem. Ind.*, 6, 799 (1887).

‖ *Ber. de Chem. Ges.*, 21, 1839 (1888).

In the case of the three other metals of this group, the atomic weight of iron has been well determined, but is now being subjected to a most careful examination in the laboratory of Professor Theodore Richards. As was supposed a few years ago to be the case with iridium and platinum, so cobalt and nickel were thought to have the same atomic weight. Then Lothar Meyer showed that, judged by their properties, nickel should follow cobalt in the periodic system and hence have the higher atomic weight. Revisions of these metals followed, but the more accurate the work the more probable it appeared that the atomic weight of nickel is below that of cobalt. It was suggested that nickel was quite probably a mixture and efforts were made to resolve it into its constituents. In this connection will be recalled the efforts of Gerhardt Kruss to decompose nickel, in which for some time he thought he had been successful and christened the new metal gnomium. But like so many other aspirants for chemists' favor, gnomium proved to be but a mixture. The latest work on these metals by Richards and Cushman and Baxter, far surpassing all that has previously been done, confirms the higher atomic weight of cobalt, and lends no support to the view that nickel is anything but a simple element.

Here we meet apparently one of those chemical mysteries, which seem to baffle our attempts at solution. We are not permitted to doubt the correctness of the general principles of the periodic system, and yet here, and the case is perhaps not unique, two elements seem to have exchanged places. When we know *why* the properties of an element are a function of its atomic weight, we shall perhaps come to understand why the atomic weight of nickel is not greater than that of cobalt.

If the chemical study of these metals supports the conception of their elementary nature, an examination of the spectrum of nickel and of cobalt, and particularly of iron, forces upon us the thought of the complexity of the atom. If each line of the spectrum, representing the vibration of a certain wave length, is occasioned by a corresponding vibration of the atom, it becomes difficult for us to conceive of so many hundred simultaneous vibrations of a simple atom, a great share of which stand in no apparent harmonic relation to each other. It has been suggested that it is by a study of the spectroscopic portrayal of atomic vibration we may hope to gain the most complete knowledge of the dynamical character of the atom, but it must be remembered that with the spectroscope we study the motion of the atom at a high temperature, when vibration apparently overcomes in most instances chemical affinity; a knowledge of the atom at this temperature may give us no hint whatever as to the nature of the atom at lower temperatures, even as the spectrum of the same element may change with varying temperature. While we might thus conjecture that perhaps by some process of careful and refined fractionation, it might be possible to resolve iron into a series of meta-elements with nearly the same atomic weight, we are met by the fact that complex though it is, we find not only the same spectrum for iron whatever its terrestrial source, but that the spectrum of sidereal iron, from meteorite, from sun, from star, gives us no evidence of any variation in the composition of iron. We are, I think justified in concluding that the nine metals of the eighth group fulfill every definition of an element, and that they are just as much to be looked upon as simple elementary substances as any of those substances which we call elements; and further that while refined determinations may change, to a slight extent, the atomic weight of some of these elements, especially those of ruthenium and osmium, we may expect the weight of these elements relative to each other, and hence their position in the periodic system to remain unchanged. This, of course, carries with it the conclusion that in the periodic table an element may have an atomic weight slightly lower than that of the element which precedes it. I have discussed this possibility briefly elsewhere,* and will only add that seeming exceptions to accepted laws, instead of overthrowing the law, often serve to broaden our conception of the law itself.

Before considering some of the compounds of the metals of the eighth group, attention must be called to the phenomenon exhibited by several of these metals, and particularly by palladium, of condensing hydrogen and other gases upon their surface. The first observation in this connection seems to have been that of Sir Humphrey Davy†, who in 1817 showed the Royal Society how a warm platinum wire, plunged into the vapor of alcohol or ether or certain other inflammable gases, became incandescent, and continued to glow as long as kept in the vapor, causing an oxidation of the gas and in some mixtures even an explosion. This phenomenon attracted great attention on the part of chemists and many were the discussions over this lamp 'without a flame' or Davy's 'aphlogistic lamp' as it was called. It was soon after noticed by Edmund Davy ‡ that the platinum reduced from solution, now called platinum black, but then platinum suboxid, is especially active and can oxidize alcohol to acetic acid. In 1823 Döbereiner announced§ that platinum black and platinum sponge, when held in a stream of hydrogen, ignite the gas and that the hydrogen is absorbed

* *Chem. News*, 80, 74 (1899).

† *Phil. Trans.*, 107, 77 (1817).

‡ *Ibid.*, 110, 108 (1820).

§ *J. für. Chem.* (Schweigger), 38, 321 (1823).

by the platinum. This was the origin of Döbereiner's hydrogen lamp, regarding which he writes under date of August 5, 1823: "You have doubtless guessed before this that I have already utilized this new observation (of the heating effect of the condensation of hydrogen) for the preparation of a new Feuerzeug and a new lamp, and that I shall put it to many other important uses."* The interest which attached to this discovery of Döbereiner's can be judged from the fact that in the literature of the decade following are found over fifty references to the subject. Little attention was, however, paid to the similar action of palladium upon combustible gases, although the phenomenon had been noticed, until in 1868, half a century subsequent to Davy's first observation on platinum, Graham presented to the Royal Society his remarkable paper on the occlusion of hydrogen by metals,† followed the next year by his papers on the relation of hydrogen to palladium,‡ and additional observations on hydrogenium.§

Graham's view that the hydrogen is present in solid form as a metal and that the palladium saturated with hydrogen must be looked upon as an alloy, was received with considerable dissent. The work of Troost and Hautefeuille|| tended to the view that the substance is a definite compound, Pd_2H. Against this is the fact that the conductivity of palladium is but slightly reduced by the occlusion of hydrogen. Calculations of the specific gravity of Graham's hydrogenium by Dewar gave the number 0.62 and the same figure is obtained for the hydrogen in hydrids of sodium and potassium, studied by Troost and Hautefeuille. The recent determinations of the specific gravity of liquid hydrogen by Dewar, however, show a figure only about one-ninth of the density of occluded hydrogen, so that the question as to the nature of the hydrogen condensed by the palladium and platinum remains still unsettled. The other metals of the group possess this property to some considerable degree, but much less than is the case with palladium and platinum. In this connection it is interesting to note that one of the earliest papers of Dewar was on the motion of a palladium plate, during the formation of Graham's hydrogenium.*

Reference has been made to the natural grouping of the elements of the eighth group into three triplets, iron, ruthenium, osmium; cobalt, rhodium, iridium; and nickel, palladium, platinum. That this is a natural grouping is attested by a comparison of the compounds of these metals. However, in considering now some of these compounds the evidence of this grouping is only incidentally presented; I desire chiefly to call attention to some of the more unusual of these compounds, especially with reference to problems which this group presents, and to problems of other groups, suggested by the chemistry of this group.

The position of an element in the periodic system is, to a very considerable extent, determined by its oxids, and that too by its highest oxids, excluding the peroxids of the hydrogen peroxid type; a considerable number of these last have been studied especially by Melikoff and Pissarjewsky of Odessa, but their character still presents many points of obscurity and cannot be used with reference to the periodic law. The triplet iron, ruthenium, osmium presents the highest oxids of the eighth group, and, as is the case with other divisions of this group, an increasing stability of the higher oxids with increasing molecular weight. The type of salts of the acid-forming oxids FeO_3, RuO_3, OsO_3, occurs in this group, as in the posi-

* Loc. cit.

† *Proc. Roy. Soc.*, 16, 422 (1868).

‡ *Ibid.*, 17, 212 (1869).

§ *Ibid.*, 17, 300 (1869).

|| *Compt. rend.*, 78, 686, 968 (1874) 80, 788 (1875).

* *Proc. Roy. Soc. Edinb.* 6, 504 (1869).

tive series of the elements of the sixth and seventh groups; viz, CrO_3 MbO_3, WO_3, UO_3, MnO_3. This type is not represented in the second or third triplet of group eight. Potassium ferrate, K_2FeO_4, exists only in solution and is very unstable; potassium ruthenate, K_2RuO_4 is stable when dry but slowly decomposes when in solution; potassium osmate, K_2OsO_4, on the other hand, has a very considerable degree of stability. Of the lower base-forming oxids, iron has not only the sesquioxid, Fe_2O_3, and monoxid, FeO, but also several intermediate oxids which may be looked upon as merely compounds of these two—such is magnetite. In the case of ruthenium, the sesquioxid, Ru_2O_3, seems to be what one might call the normal base-forming oxid. The different conditions which occasion the formation of the lower oxids of osmium are ill known, though several different oxids seem to exist, as OsO, Os_2O_3, and OsO_2. Much more interest, however, attaches to the tetroxids of ruthenium and of osmium, RuO_4 and OsO_4, which are the highest volatile oxids of any known element. The almost intolerable odor of osmium tetroxid incited Tennant, in 1803, to give its name to this element, while ruthenium tetroxid, first noticed by Claus, has, if not too concentrated, a rather fresh pleasant odor, with just a suspicion of the smell of ozone, due probably to the formation of ozone in the decomposition of the oxid. As far as physical properties go, these oxids, while solid at ordinary temperature, melt easily and can be distilled. Ruthenium tetroxid is, however, far less stable than the corresponding osmium oxid, for it decomposes slowly at ordinary temperature, and explodes with great violence if heated much above 105°. On one occasion Deville and Debray* attempted to distil a hundred and fifty grams of ruthenium tetroxid, and when the temperature reached a little above 100°, the whole mass exploded with terrific violence, filling the laboratory with a dense sooty smoke. In a recent similar explosion in my own laboratory, occasioned by the contact of a little alcohol with ruthenium tetroxid, but happily on a much smaller scale than that of Deville and Debray, this black soot was found to be readily soluble in hydrochloric acid. This is unexpected, as all the anhydrous lower oxids of ruthenium are insoluble in acids, and from its methods of formation the black substance could hardly be anything other than an anhydrous oxid or the metal itself. Osmium tetroxid is commonly known as osmic acid, but as a fact these tetroxids are neither acid-forming oxids nor are they peroxids in the ordinary acceptance of the term. When treated with an alkali, we have a gradual reduction with formation of perruthenate and ruthenate, or of osmate.

Turning to the third triplet, we have the monoxid of nickel well characterized, and it is, we may say, the only well-characterized oxid of the metal, for though higher hydrated oxids of nickel exist, and perhaps anhydrous oxids also, their composition is not definitely known. With palladium and platinum also, monoxids seem to exist and dioxids as well (PdO_2 and PtO_2). Platinum dioxid may be looked upon as being perhaps a very weak acid-forming acid. While nickel forms practically only the monoxid NiO, and iron forms from choice, as we might say, the sesquioxid, Fe_2O_3, the intermediate metal cobalt, while forming most generally the monoxid, is easily oxidized to the sesquioxid, Co_2O_3, and thus cobalt may be considered in its relations to oxygen, as intermediate between nickel and iron. Similarly in the case of rhodium and iridium, there is a strong tendency to form the sesquioxid, so that this middle triplet is intermediate between the other two triplets of the group. As a whole, there is a large field at hand in a revision of the

* *Ann. Chim. Phys.* [5], 4, 537 (1875).

oxids of this group, especially those of the first triplet.

The same may be said even more emphatically of the sulfids. Those of iron, cobalt and nickel are fairly well investigated, but of the remainder comparatively little is known except the somewhat exhaustive work of Schneider on the thioplatinates and thiopalladates. After a very considerable amount of work upon the sulfids of ruthenium, I have come to distrust nearly all that has been published and to have nothing definite to add myself. The precipitates with hydrogen sulfid from ruthenium solutions ($RuCl_3$) contain apparently a considerable amount of free sulfur, but oxidize very rapidly with formation of sulfuric acid on drying, making their composition very difficult of determination. From ruthenate solutions a sulfid is precipitated which seems to have the formula RuS_3, but there is no assurance that a part of the sulfur may not be free and not combined.

Of all the compounds of the metals of the eighth group, by far the best investigated are those with the halogens, and upon our knowledge of these rests the greater part of our chemical knowledge of the platinum metals. Yet here again our knowledge is wholly inadequate. If we except the work done under Wöhler's direction by Oppler and Birnbaum on the bromids and iodids of iridium, that by Topsöe on the bromids and iodids of platinum, we may say that very little is known of any halids of this group except the chlorids. In some instances, as with ruthenium, even the chlorids are very unsatisfactorily known. Of nickel we know only the bichlorid $NiCl_2$; of cobalt the only stable chlorid is the bichlorid, $CoCl_2$, but the trichlorid, $CoCl_3$ seems capable of existence in solution; of iron, the ferric chloride, $FeCl_3$, is the stable compound, into which the ferrous chloride, $FeCl_2$, is readily oxidized. Here again the intermediate position of cobalt is apparent. There is a strong tendency on the part of all these chlorids to form double salts, of which we have examples in K_2FeCl_4, $3H_2O$, K_2FeCl_5, and Rb_3FeCl_6. These salts seem to be broken up in solution and the chlorin can be precipitated by silver nitrate. Turning to the halogen compounds of the platinum metals, we find double salts of a very different character. The common types for platinum and palladium, for example, are K_2PtCl_4 and K_2PtCl_6. This latter type seems also to be known for all platinum metals except rhodium. Osmium, iridium, and rhodium present also the type K_3OsCl_6, while ruthenium and rhodium also form salts of the type K_2RuCl_5. The most important features of these salts is that they are not decomposed when dissolved in water, silver nitrate precipitating not silver chlorid alone, but the double chlorid of the metal and silver; that is, for example, when K_2PtCl_6, is dissolved in water, it is electrolytically dissociated, K being the positive ion, while the negative ion is the group $PtCl_6$. The platinum metal then in these salts is a part of the negative ion. Double salts of this class are, of course, well known, but nowhere are they developed to the same extent as in the eighth group, indeed double salts of several acids are found among no other metals. The question may be fairly raised among the platinum metals as to whether there is any salt which is electrolytically dissociated giving the platinum metal as the positive ion.

The chlorids of ruthenium furnish an instructive illustration of the difficulties which may arise in getting complete knowledge of chemical facts as to what would naturally be considered simple substances. As we have seen, Claus discovered ruthenium in 1844. He obtained two chlorids or rather double chlorids, the one K_2RuCl_5 and the other K_2RuCl^6, the former corresponding to the type found in osmium and rhodium, the latter to that found in platinum and palladium as well as in iridium and osmium. In describing this latter salt, Claus shows that it was in the hands of Berzelius and probably in a pretty pure state, but that great chemist thought it to be an iridium salt, Berzelius was not convinced, and in the 'Handwörterbuch der reinen und angewandten Chemie,' edited by Liebig, Poggendorff and Wöhler, the work of both Berzelius and Claus is given. This was naturally somewhat irritating to Claus and he writes:* "Even if reverence for the great authority of the great chemist (Berzelius) should seem to justify such a course, regard for the truth of science should not have permitted it." The subject was now dropped and for a third of a century no one had worked upon this chlorid, when Professor A. Joly, of the l'École Normale, began his study of the platinum metals, and much of the work of Claus upon ruthenium was revised. Now it appears that not only Berzelius, but also Claus himself was mistaken, and what he had taken for a chlorruthenate, K_2RuCl_6, was in a reality a *nitroso chlorruthenate*, K_2RuCl_5NO. My own work of a little later date upon the chlorids of ruthenium abundantly confirmed this. Many efforts were made to prepare a tetrachlorid of ruthenium but it proved elusive. It may be noted in this connection that the cesium and rubidium nitrosochlorids exist in an anhydrous as well as in a hydrated form and while the very easily soluble hydrated salts lose their water on warming the solution, the very slightly soluble anhydrous salt being precipitated, the reverse change is seemingly impossible, as the anhydrous salt will not take up water and pass back into the hydrated form.

The history of the higher chlorid of ruthenium is not yet completed. Within the past year Professor Ubaldo Antony and A. Lucchesi, of the University of Pisa, have described* the preparation of the real tetrachlorid, K_2RuCl_6, which like the corresponding salts of platinum and the other metals of the group, crystallizes in octahedra. I have more recently by methods similar to those of Antony, prepared the cesium salt, Cs_2RuCl_6, which also crystallizes in octahedra and corresponds to Antony's salt; and I have also been fortunate enough to obtain a new salt of a rare type, lying intermediate between the tetroxide and the tetrachlorid, $Cs_2RuO_2Cl_4$ ($2CsCl, RuO_2Cl_2$). Now a question may arise here as to whether Claus was after all, wrong in believing he had the tetrachlorid. As the salt was commonly made by Claus, by the action of nitric acid, it was, without question, a nitrosochlorid, and his description corresponds completely; but Claus adds in a footnote † that it is also possible to prepare the salt by heating the trichlorid with potassium chlorate and hydrochloric acid. This could not give the nitrosochlorid, but while under these conditions the tetroxid is usually formed, it is possible that the tetrachlorid may also have been formed. In another place he speaks of making it by action of hydrochloric acid on potassium ruthenate, but in the presence of saltpeter. Except for this latter salt, this is the method of Antony, but usually at least it gives the trichloride. The salt which Claus generally describes is the nitrosochlorid, but in one place ‡ he says the salt seems to be dimorphous, for after crystallizing out the common prismatic crystals (of the nitrosochlorid) he, on one occasion, obtained large regular octahedra, isomorphous with tetrachlorids of the other platinum metals. As the molecular weight of the nitrosochlorid is almost the same as that of the

* *Bull. Akad. St. Petersb.* (2), 108, 1 (1860).

* *Gazz. chim. ital.*, 29 i (1899).

† *J. prakt. Chem.*, 39, 96 (1846).

‡ *Bull. Akad. St. Petersb.* (2), 1, 105 (1860).

tetrachlorid, and as the chlorin seems to have been generally estimated by loss, analysis would reveal no discrepancy, but in one case at least, the chlorin was directly determined, and these figures can be accounted for only on the supposition that in this case it was a tetrachlorid which was analyzed; so that it would seem possible that Claus actually formed the tetrachlorid, although he did not distinguish it from the nitrosochlorid. Even now the conditions of formation of the tetrachlorid are obscure, and not less so is the cause of a phenomenon, noticed first by Claus, and since his day used as a test for the detection of ruthenium, and which is familiar to all of you who have experimented at all with this metal. I refer to the beautiful indigo-blue color assumed by the solutions of ruthenium trichlorid when hydrogen sulfid is led into them. Since, at the same time, sulphur is precipitated, and since the trichlorid also assumes a blue color on treatment with metallic zinc,* it was assumed by Claus that reduction takes place and hence that the solution contains ruthenium bichlorid, $RuCl_2$. When ruthenium is heated in a current of mixed chlorin and carbon monoxid, it increases many times in volume and there is formed an anhydrous trichlorid. This is insoluble in water and in strong alcohol, but dissolves with considerable readiness in dilute alcohol to a similar deep blue solution. Joly succeeded in distilling off the alcohol and water from this solution, in a vacuum, and obtained a blue deliquescent substance which he considered to be an oxychlorid, $RuOHCl_2$. I have also formed this blue solution by electrolytic action, and while it seems to be formed by a reducing action, this is not perfectly clear. Considerable work upon this solution, however, leads me to agree with Claus that it is probably a lower chlorid of ruthenium, but it has not been proved. I have dwelt perhaps unduly upon these compounds for the purpose of showing the obscurity in which even such seemingly simple points are enveloped, for it well illustrates how much work must yet be done before we acquire any adequate knowledge of the nature of even the commoner compounds and reactions of these elements.

Of the simple salts of oxy-acids few are known of any metals of this group except the lower series, iron, cobalt and nickel; a single sulfate of rhodium, one of palladium, and perhaps a double sulfate of platinum, a chromate of iridium, a basic carbonate of palladium, two or three nitrates, a phosphate of rhodium, and a hypophosphite of platinum; such is practically the whole list. The platinum metals have little tendency to form crystalline salts with oxy-acids, and many such salts are unquestionably incapable of existence, but in many cases at least the difficulty is our ignorance of the condition of formation of such salts. And herein, I may say, is one of the most marked differences between investigation in organic and in inorganic chemistry. In the former the field has been so thoroughly studied that the conditions of reaction are often well known and the course of a reaction can be foretold with considerable certainty; in inorganic chemistry the work is like exploration in an almost wholly unknown land. We know neither the possibility of existence of conjectured compounds, nor the conditions under which alone such formation or existence is possible. For this reason inorganic research is slower and far more apt to be fruitless. No better example of this can be cited than the fact already referred to that Professor Joly, as well as myself, exhausted every method which occurred to us for the formation of the tetrachlorid of ruthenium, and failed in our efforts by missing just the proper con-

* It has already been mentioned that Vauquelin had noticed this blue color, but not knowing of ruthenium had attributed it to osmium.

ditions, which happily Professor Antony has hit upon.

But while the platinum metals seem to form few simple salts, few or none show such a decided tendency to form double and complex salts, and this property is, to some extent, shared by the three light metals of the group.

Best known and best developed of these compounds are the cyanids, which are especially familiar to us in the prussiates of iron. In nickel we have the ordinary cyanid, $K_2Ni(CN)_4$ or 2KCN, $Ni(CN)_2$, formed by the solution of nickel cyanid in potassium cyanid. As electrolytically dissociated, the nickel is a positive ion, and the double salt is at once broken up by acids with the precipitation of nickel cyanid. The double cyanid of palladium, $K_2Pd(CN)_4$ is similar but less easily decomposed. The corresponding double cyanid of platinum, $K_2Pt(CN)_4$ is clearly a salt of the complex platinocyanic (or cyanoplatinous) acid, $H_2Pt(CN)_4$, which is formed on treating the salt with a strong acid, can be separated in a pure condition, and is an acid strong enough to expel hydrochloric acid from sal ammoniac. The platinum atom is here a constituent of the negative ion, $Pt(CN)_4$.

If we proceed from nickel along the horizontal series, we find that while a double cobalt cyanid, $K_4Co(CN)_6$ or 4 KCN,-$Co(CN)_2$, can be formed, it is very unstable, and belongs to the same easily decomposable class as the double nickel cyanids. This cobalt cyanid has, however, a great tendency to oxidize and form potassium cobalticyanid, $K_3Co(CN)_6$, which is stable and a salt of the cobalticyanic acid, which can be obtained in a free state. In passing we note a very interesting point, that under the influence of such reducing agents as potassium cyanid, potassium nitrite, and potassium sulphite, cobalt shows a great tendency to become oxidized from its bivalent condition to the very stable complex compounds in which it is trivalent; under other circumstances, simple compounds in which cobalt is trivalent are formed with great difficulty and are of decided instability. This seeming anomalous property still demands an explanation.

Turning to the iron cyanids we find both types, $K_4Fe(CN)_6$ and $K_3Fe(CN)_6$, ferrocyanid and ferricyanid, well developed and extremely stable. From each, the corresponding acid can be obtained in a free state, and is a strong acid. Of the remaining metals, the double cyanids of rhodium and iridium resemble the cobalticyanid, while of iridium the iridocyanid, $K_4Ir(CN)_6$ is also known, and is stable, thus completing the analogy found in the nickel group. Potassium ruthenocyanid, $K_4Ru(CN)_6$ and osmocyanid, $K_4Os(CN)_6$ resemble the ferrocyanid, the free acids being easily separable from the salts. Outside of the eighth group, the stable complex cyanids are known only in the case of manganese and chromium.

Regarding the constitution of the double cyanids, you are all familiar with the various suggestions that have been made from time to time, which involve the polymerization, probably by threes, of the cyanogen group. To this there have been raised two objections: an explanation which is satisfactory for the double cyanids should also be available for the double chlorids, as K_2PtCl_6 which are also salts of complex acids, and where polymerization by threes is at least improbable; and second it is possible to replace a single cyanogen group or chlorin atom, without changing essentially the nature of the molecule, as in sodium nitroprussid, $Na_2Fe(CN)_5NO$, and potassium nitrosochlorruthenate, K_2RuCl_5NO. There is a large field for study in these cyanids from the standpoint of the newer physical chemistry.

Closely connected with the chemistry of the cyanids is that of the thiocyanates, but it has been very meagerly worked out for the eighth group. In the case of platinum both potassium plato- and platithiocyanates, $K_2Pt(SCN)_4$ and $K_2Pt(SCN)_6$, are known, and are salts of the plato- and platithiocyanic acids. These are complex acids and may be separated out, but in the free state are very unstable. The double ferric thiocyanates may be formed but there is no corresponding complex acid, that is, they are ordinary double salts. The ferrous, cobaltous, and nickel thiocyanates are known, but form no double salts. It is extremely probable that the other metals of this group would show a full series of thiocyanates.

Another interesting class of complex salts is that of the double nitrites, first studied in the case of platinum by Nilson, but for the other platinum metals by Wolcott Gibbs, who bases upon these his method of separating the metals. More recently these nitrites have been investigated by Joly, Vèzes, and Leidié. The most familiar double nitrite is the potassium cobaltinitrite, which has long served for the separation of cobalt from nickel, and which is also used as a pigment under the name of aureolin or cobalt-yellow. These nitrites resemble, to a considerable degree, the double cyanids, and in the case of iridium the free complex iridonitrous acid has been obtained. In the case of iron, cobalt, and nickel, we have also representatives of a large class of very staple triple nitrites, first noted by Künzel and Lang and studied by Erdmann.* More recently these have been investigated by Przibilla † who, after great difficulty, succeeded in preparing the triple iron potassium nitrites with lead, barium, strontium, and calcium; this is the first nitrite of iron to be prepared and leaves osmium as the only metal of the eighth group of which no nitrite is known.

* *J. prakt. Chem.* 97, 385 (1866).

† *Ztschr. anorg. Chem.*, 15, 419 (1897).

In the case of all platinum metals double sulfites are known, which are salts of complex metallo-sulfurous acid. In these metals the presence of the sulfurous acid radical cannot be detected by ordinary reagents. In the case of cobalt, a full series of cobaltisulfites is known, which are stable salts, while the cobaltosulfites are very unstable. Little is known of iron and nickel sulfites, and there is much room for further investigation in the case of the sulfites of the other elements of this group. There is at the same time reason to believe that a study of the thiosulfates and possibly the dithionates of this group would not be without interest.

Another acid which is capable of forming complex salts is oxalic. The platoxalates are the only ones which have been carefully studied, though some work has been done upon the rhodoxalates. Several iron oxalates and double oxalates are known, but aside from this the field is unworked but promising. In this connection it may be added that while oxalic acid is the only organic acid which has been investigated to any considerable extent in complex salts, it by no means follows that it is the only acid which is capable of entering into such combinations. Some of my students have made preliminary tests with a large series of acids and found that several among them enter combination with chromium with the formation of complex salts, and it is quite possible that similar compounds may be formed with the eighth-group metals. Mention should also be made that Gibbs has introduced platinum into his complex salts, forming platinimolybdates and platinitungstates.

Since complex salts of hydrocyanic, nitrous, sulfurous, oxalic, and other analogous acids are best developed generally with the metals of this group, it is in the study of these and other compounds of this group that we may hope to gain an insight into the constitution of these interesting compounds of which so little is known, and further extend our knowledge regarding valence, for it is just at this point that the generally accepted theory of valence begins to break down.

Before alluding to the ammonia bases, which are so well developed in this group, and would naturally follow these complex salts we have just considered, a brief digression may be made to refer to three classes of anomalous compounds, which should not be passed without reference. The first of these is the nitroso compounds. It is only recently that, largely through the efforts of Joly, the nature of the so-called nitro-prussids was discovered,—double cyanids in which one cyanogen group is replaced by one nitroso group, NO. Joly then found that the old osmiamic acid of Fritzsche and Struve is also to be considered as a nitroso compound, and that the supposed tetrachlorid of ruthenium is, in reality, a nitroso-chlorid. But while there appear to be no representatives of the nitroso compounds in the cobalt or the nickel groups, several other compounds of iron are known which contain this group, as the potassium iron tetra- and heptanitroso-sulfonates, $K_2Fe_2(NO)_4S_2$ and $KFe_4(NO)_7S_3$, and the iron nitroso-thiocarbonate and thio-antimonate of Löw. There seems also to be a nitroso-cyanid of ruthenium, corresponding to the nitroprussids, but it has not been isolated. In none of these cases has the interesting question been brought out as to whether the nitroso group remains attached to the metal when in solution, or whether it is electrolytically dissociated and acts the part of an acid radical.

In some respects yet more remarkable are the compounds formed with carbon monoxid and with phosphorus trichlorid. The best known compound of this class is the nickel carbonyl, $Ni(CO)_4$ of Ludwig Mond. The nature of this volatile liquid is yet unknown, but it is by no means unique. Immediately after its discovery it was found that iron formed similar compounds, $Fe(CO)_5$ and $Fe_2(CO)_7$. That a volatile compound of iron exists had been very apparent on the lime of the Drummond light, when water gas, compressed in iron cylinders, was used instead of hydrogen, and also in the clogging of gas burner tips with an oxid of iron, especially when a carburetted water gas is used as an illuminant. The volatile iron carbonyl seems to be formed at ordinary temperatures by the passage of carbon monoxid through iron pipes. But it is not alone with metals that carbon monoxid combines to form volatile compounds. As early as 1868 Schützenberger* discovered that platinous chlorid $PtCl_2$ would combine directly with carbon monoxid, with the formation of three distinct compounds, containing respectively one, two and three molecules of CO to one of $PtCl_2$. A compound is also known in which one CO group replaces one cyanogen group in potassium ferricyanid, that is $K_3Fe(CN)_5CO$. This reminds us naturally of the nitroso-ferrocyanid, the so-called nitroprussid. Again in 1870 Cahours and Gal† discovered a series of compounds containing platinous chlorid united with phosphorus trichlorid, and also with some of the organic phosphins. These compounds are not of the nature of double chlorids, for they can be hydrolyzed with the formation of chlorplatophosphorous acid. An analogous class of compounds of iridium has been made by Geisenheimer,‡ which are also capable of hydrolysis, giving chloriridophosphorous acid. Geisenheimer has formed similar compounds con-

* *Compt. rend.*, 66, 666, 747 (1868).

† *Comp. rend.*, 70, 897, 1380 (1870); 71, 208 (1870).

‡ *Comp. rend.*, 110, 1004 (1890).

taining bromin* in the place of chlorin, and also others containing arsenic† in the place of phosphorus. How far compounds of this nature can be extended is only conjectural, but there is evidence of the existence of something of the kind with iron.

Of binary compounds with the less negative elements, such as the phosphids and carbids of iron, little is known. Like iron, nickel and also platinum and iridium form phosphids. Iridium phosphid possesses an economic importance in that it enables the metal to be fused in a furnace. Up to the discovery of this process in 1882 by Dr. Wm. L. Dudley, the native grains of iridosmium were alone available for tipping gold pens, stylographs, and the like. It was, however, found that when iridium was heated to a high temperature in a crucible, on introducing a piece of white phosphorus, the whole mass immediately melted, and could be cast into plates, afterward to be worked up into desired form. This reminds one of the early method of working platinum by alloying it with arsenic and then roasting the arsenic off in a muffle.

There remains a single class of compounds to be noticed, the ammonia bases, whose greatest development is found in this group. The first member of this class was the compound now known from its discoverer as the green salt of Magnus, which was first made in 1828.‡ Then came the work of Gros, of Reiset, and of Peyrone. Among the many chemists who have cultivated this field are Cleve, Jörgensen, who has given us most of our knowledge of the rhodium bases; Gibbs, Palmaer, who has developed the iridium bases, and Joly, who has revised the bases of ruthenium; while the theory of these bases has been discussed especially by Claus, Blomstrand, Jörgensen, and Werner. In connection with these bases appear what must, with our present knowledge, be considered anomalies. The greatest development of these bases is found with platinum, where nearly or quite a dozen distinct classes of bases are known, and where we find several groups of isomers, which Werner seeks to explain as stereo-isomers, while Jörgensen strenuously combats the view. In type, the palladium bases resemble those of platinum, but as far as yet studied are much less well developed. Nickel, on the other hand, forms no true bases, though many ammonia compounds. The cobalt, rhodium, and iridium bases are all formed on the same general types, but by far the greatest development is found in cobalt, which almost rivals platinum in the number of classes; but few of these are developed with iridium, and fewer still with rhodium. In the iron group no bases are formed by iron, and only two or three ammonia compounds; ruthenium and osmium form fewer bases as far as yet investigated, than any of the other platinum metals. It it interesting to note, however, that one of these ruthenium bases, discovered by Joly, and which possesses intense tinctorial power, resembles very strongly an organic dye, both on fabrics and as a stain in microscopy. The constitution of the ammonia bases is to-day, as it has been for half a century, one of the greatest problems of inorganic chemistry, and it is apparently no nearer solution. In accordance with the valence theory, it becomes necessary with Jörgensen to assume the existence of chains of at least four NH_3 groups in a molecule, stable enough to be unaffected by aqua regia and also that these ammonia groups are replaceable by water molecules. We must also assume that while in ordinary salts, as for example chlorids, the chlorin atoms, which are directly united with the metal, are dissociated in aqueous solution, in these bases the chlorin which is directly united with the metal is not dissociated, but

* *Ibid.*, 111, 40 (1890).

† *Ibid.*, 110, 1336 (1890).

‡ *Ann. der Phys.* (Pogg.), 14, 239 (1828).

that which is united with the metal through the medium of one to four ammonia groups is dissociated. Led by a consideration of these seeming inconsistencies, Werner has proposed his theory of co-ordinated groups within the molecules; a theory which seems to possess at least elements of truth, even if not expressing the whole truth. It is possible, too, that Werner's theory may explain some of the difficulties of the theory of electrolytic dissociation, and harmonize it with the hydrate theory of solution.

The constitution is, however, not the only problem of these bases. To my mind their connection or rather lack of connection with the periodic system is one of the most inexplicable facts in chemistry. It makes it apparent that while the periodic law expresses a truth without doubt the greatest generalization of modern chemistry, yet even this is in its present statement not the whole truth. We find a marvelously full development of these bases in connection with cobalt, platinum, and chromium. Manganese and iron which lie between chromium and cobalt form no bases. The higher members of the chromium group, that is, molybdenum, tungsten, and uranium, form no bases, while the higher members of the iron series, that is, ruthenium and osmium do. Of nickel, which stands next to cobalt and resembles it so closely, no bases are known, and yet it is the lowest member of the series which contains platinum. It is true that bivalent cobalt forms perhaps like nickel, no bases, but as trivalent cobalt forms so many bases, trivalent iron would seem likely to form many, instead of none. If indeed manganese and iron are capable of forming these bases, it seems strange that no one has yet happened upon the proper conditions. It is the consideration of a subject like that of these inorganic bases, which forces upon us a realization of how much there is after all which we do not know about chemistry.

We turn now to a short consideration of the eighth group from a theoretical stand-

Periodic Table By F. P. Venable—Modified.

H															He	
Li		Gl		B		C		N		O		F			Ne	
Na		Mg		Al		Si		P		S		Cl			Ar	
K	Cu	Ca	Zn	Sc	Ga	Ti	Ge	V	As	Cr	Se	Mn	Br	Fe	Co ? [82]	Ni ? [84]
Rb	Ag	Sr	Cd	Y	In	Zr	Sn	Cb	Sb	Mo	Te	▬	I	Ru	Rh ?	Pd ?
Cs	?	Ba	†	La	†	Ce	†	*	†	*	†	*	†	*	*	*
*	Au	*	Hg	*	Tl	*	Pb	Ta	Bi	W	†	*	†	Os	Ir	Pt
* + Series	— Series	* +	—	* +	—	Th +	—	* +	—	U +	—	+	—			

* Possible + Series elements. † Possible — series elements. ▬ Eka-manganese.

point. Following Dr. Venable* we may assume that each of the first seven groups consists of a group element, as in group one, lithium, a type element as sodium, and two series, one of more positive elements as potassium, rubidium and cesium, and the other more negative, as copper, silver and gold. Further, the more positive the type metal, the more closely will the metals of the positive series resemble it; the more negative the type metal, the more closely will the negative series resemble it. Thus in the first group, the positive series potassium, rubidium and cesium closely resembles the type element sodium; in the seventh group the negative series, bromium and iodin, resembles the type element chlorin. Now the eighth group differs materially from the other seven in that it contains three series, with no group or type element. These three series are transitional from the least positive among the seven positive series, manganese, to the least negative among the negative series, copper, silver and gold. The properties of the metals of group eight show this transition as from a chemical standpoint, iron, cobalt and nickel form a direct gradation between manganese and copper. Now comes a further question as to possible transition elements between the most negative series, fluorin, chlorin, bromin, iodin, and the most positive series sodium, potassium, rubidium and cesium. From a theoretical standpoint such transition elements should be neither positive nor negative, and should have a valence of zero. A few years ago the realization of such a conclusion would have seemed impossible, yet since the discovery of argon and its congeners, it seems almost probable that these places have been filled in accordance with theory. If we take the most generally accepted atomic weights, we find helium preceding lithium, neon following fluorin and preceding sodium, and argon, really between chlorin and potassium, but with an atomic weight apparently slightly greater than that of potassium which follows it, resembling in this respect cobalt and nickel of this same group, and also tellurium and iodin. There would, in addition, be expected from the analogies of group eight, one, two, or three transitional elements between bromin and rubidium, of atomic weight, 80 to 85, and Ramsay has suggested that krypton may belong in this place—so also an element or elements of similar character might be expected between iodin and cesium, with atomic weight of about 130. The recently published work of Ladenburg and Kruegel on krypton give it an atomic weight of about 59. This would, as Professor Ladenburg suggests, make it immediately precede copper, but unless we change very materially our ideas of the periodic law, it is difficult to conceive of an element with the properties of krypton lying between nickel and copper. If these inert gases belong in the eighth group it may seem strange that iron and the other familiar metals which belong here should be so unlike such a type element as argon or neon; it must, however, be borne in mind that this is only an expected exaggeration of the departures found in the first and seventh groups, where copper departs from its type element sodium, and manganese from its type element chlorin. As to whether three elements are to be expected of atomic weight 150 between the light and the heavy platinum metals we have little data upon which to theorize. As a matter of fact, there is very little definite knowledge of the elements between cerium and tantalum. The inter-Jovian planet proved to be an indefinitely large number of asteroids; Sir William Crookes' study of the rare earths leads him to the conception of a group of asteroidal meta-elements in this vacant space in the periodic table. We must await further knowledge be-

*See periodic table.

fore these problems can be satisfactorily solved.

In conclusion one word as to a very practical problem connected with this group. It is but a few years past a century since the use of platinum was introduced into the chemical laboratory. For a few decades the supply exceeded the demand, but the applications of platinum have steadily increased, and never so rapidly as in the last two decades. For many purposes no substitute for platinum has been found. At the same time the supply of platinum is not keeping pace with the demand, and as a result the price of platinum has very materially advanced. While platinum is very widely distributed, there are few places where it occurs in workable quantities. It is possible, however, that it has been often overlooked, as in placer mining for gold, and efforts have been made to attract miners' attention to more careful search for platinum deposits. At the present outlook it will, within a few years, be imperatively necessary either to materially increase the platinum supply of the world or to replace it for many purposes by some other substance. How this problem will be solved cannot now be foreseen.

Jas. Lewis Howe.
Washington and Lee University.

SCIENTIFIC BOOKS.

The Elements of Physics for Use in High Schools. By Henry Crew, Ph.D., Professor of Physics in Northwestern University. New York, The Macmillan Company. 1899. Pp. 347.

One of the most striking indications of the steadily increasing demand for instruction in science as a part of elementary education, is found in the periodic recurrence of new books on a market that would seem to have become already overcrowded. If the new competitor is written by one who manifests his possession of the teacher's instinct in addition to the scholar's knowledge, its reason for existence is quickly established. The author of the present volume plainly shows himself to be the possessor of both, though as a teacher he may have had little experience in the grade of schools for which his book is intended. In the preface he expresses his obligations to one friend, a high school teacher, 'for many important excisions in the MS.,' and his readiness to have others 'point out sins either of omission or of commission.'

In criticising such a book it is a pleasure to find so little to condemn, even if a few more excisions may seem advisable. Physics is essentially applied mathematics, even when no attempt is made to introduce openly the ideas of calculus or even of trigonometry. It is most natural therefore that a physicist, who is not himself a high school teacher, should overestimate the ability of the average high school pupil to grasp mathematical conceptions that are not usually introduced in the work of the secondary school.

In the introductory chapter on motion a brief and clear exposition of vectors and scalars is given, and a subsequent application is made in the discussion of uniform motion in a circle, where the position vector and velocity vector are contrasted, and the nature of the path deduced, along with the formula for acceleration in terms of radius, angular velocity, and periodic time. There is no theoretic objection to this, but it is probably safe to predict that many secondary pupils will agree in thinking the discussion much too abstract for them. Indeed it would not be hard to find college juniors of literary bent, who would be sympathetic with their friends in the preparatory school, and who would congratulate themselves on the absence of problems, necessary as these may be to bring home a difficult subject. There are fashions in educational method as well as in dress. Whether the vector analysis fashion can be maintained in elementary schools may be doubted. To immature students the method is certainly not so easily grasped as are some other methods that have hitherto been satisfactory to many.

In the discussion of angular motion much stress is laid upon the distinction between speed and velocity, the former being a scalar and the latter a vector quantity. This distinction has been more or less familiar ever since its introduction by Thomson and Tait, but to young students it can scarcely fail to bring uncompensated trouble. Among the problems on this subject is the following: "What is the aim of the clockmaker; to produce an instrument which will give constant angular speed or constant angular velocity?" It is perhaps safe to say that few clockmakers would answer with confidence; and probably some teachers would hesitate also, especially after trying to assure themselves that "an ordinary peg top may be used to illustrate the case of a body having a constant angular speed, but at the same instant a variable angular velocity." For mental gymnastics in following out the metaphysics of a definition the distinction may have its value; but there are many whose maturity exceeds that of high school pupils, and who find the word velocity, with suitable adjuncts, quite enough for all practical purposes. The facts give little trouble, for velocity in any given direction can always be specified, while words may become tyrants.

As an exact science physics is built up on dynamics as a foundation. The study of linear, angular, and harmonic motion therefore constitutes its most natural introduction, along with the consideration of the general properties of matter, of momentum, rotational inertia, and universal gravitation. Each of these subjects is treated with intelligence and skill, with mathematics that is not abstruse for a college student, but in a style that seems rather severe for the preparatory schools. Indeed the first hundred pages of the book, relating to subjects that admit of but little experimental illustration, are certainly rather hard for students below collegiate grade. Passing on then to wave motion and acoustics, the rest of the volume is non-mathematical and very attractive.

In the discussion of sound the building of the musical scale is brief, yet clear; but it seems a little unfortunate that the frequency of middle *C* should be given as 264. This number was adopted by the Stuttgart Congress in 1834, and the scale built upon it was used in Helmholtz's 'Sensations of Tone'; but it never won universal adoption. Within the last few years, and largely through the activity of the late Governor L. K. Fuller, of Vermont, all the civilized nations of the world have adopted *A*, 435, as standard pitch for the construction of musical instruments, England being the last to yield. As all keyed instruments are made with the aim of producing the equally tempered scale, rather than the diatonic scale, it is readily found, by application of the proper factor, $(1.05946)^{-9}$, that the frequency of the middle *C*, for this international pitch, is 258.65. For the purpose of the physicist the diatonic scale will probably continue in use, and Koenig's forks are universally regarded as the best. These are tuned, unless specially ordered otherwise, to the so-called physical pitch, introduced a century ago by Chladni, with $C_3 = 256$. The wild confusion of a generation ago has now been reduced to order, with the survival of but two definitely related systems. One of these is international pitch, with $A_3 = 435$ as starting point for the scale of equal temperament; the other is physical pitch, with $C_3 = 256$ as starting point for the diatonic scale. Each of these is of course arbitrary, the result of agreement, while the equally arbitrary Stuttgart pitch is now of only historic interest. In a text-book of physics it may be mentioned, but should no longer be taught; and 256 rather than 264 should be the basis for a diatonic table of frequencies.

The closing chapters on heat, magnetism, electricity, and light are well arranged, clearly expressed, and modern in style of treatment, with judicious omission of much that the high school pupil can well afford to disregard until the subject is resumed in college. For example, the polarization of light is not mentioned, while diffraction comes in as an elementary illustration of the wave theory, a few simple experiments being explained which are both interesting and easily made. In the development of the laws of geometrical optics, wave fronts are freely indicated in the diagrams, but equally free use is made of the convenient term 'ray.' The fact that this means merely a direction is no reason for abolishing it, as has been done in a few recent text-books of physics.

W. Le Conte Stevens.

Washington and Lee University.

BOOKS RECEIVED.

Photometric Measurements. Wilbur M. Stone. New York and London. The Macmillan Co. 1900. Pp. vii + 270. $1.60.

A Manual of Elementary Practical Physics for High Schools. Julius Hortvet. Minneapolis, H. W. Wilson. 1900. Pp. x + 255.

Comparative Anatomy of Animals. Gilbert C. Bowne. London, George Bell & Sons. 1900. New York, The Macmillan Co. 1900. Pp. xvi + 269.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for June opens with an excellent account of 'The Neurone Theory in the Light of Recent Discoveries,' by G. H. Parker, originally given as a lecture before the Section of Biology, New York Academy of Sciences. 'Variation in the Venation of Trimerotropis,' is discussed by Jerome McNeil, with the rather surprising conclusion, among others, that variations in venation may be much greater within a species, than those difference which distinguish one genus from another. Robert T. Young presents some 'Notes on the Mammals of Prince Edward's Island,' and T. D. A. Cockerell notices 'The Cactus Bees, Genus *Lithurgus*' recorded from New Mexico. C. B. Davenport summarizes 'The Advance of Biology in 1897' as indicated by the contents of *L'Année biologique* for that year and F. W. Simonds has a paper, presented before the American Association last August, 'On the Interpretation of Unusual Events in Geologic Records, illustrated by Recent Examples.' Part X of the 'Synopses of North American Invertebrates' is by Mary J. Rathbun and is devoted to 'The Oxyrhynchous and Oxystomatous Crabs.'

The Popular Science Monthly for July has for its frontispiece a portrait of G. K. Gilbert. Simon Newcomb has some 'Chapters on Stars' and W. M. Haffkine gives the second and final part of his very interesting article on 'Preventive Inoculation.' James Collier presents the second of his papers on 'Colonies and the Mother Country' and G. F. Swain gives an account of 'Technical Education at the Massachusetts Institute of Technology,' which includes the history of the institution in brief and is illustrated by views of the laboratories and portraits of its various Presidents. G. T. W. Patrick discusses 'The Psychology of Crazes,' concluding that ethically and intellectually social or collective man is far behind individual man. Edward Renouf considers 'Some Phases of the Earth's Development in the Light of Recent Chemical Research,' and S. P. Langley contributes 'A Preliminary Account of the Solar Eclipse of May 28, 1900, as observed by the Smithsonian Expedition.' 'Malaria and the Malarial Parasite,' by Patrick Manson, gives a good resumé of the subject, and finally Henry Carrington Bolton briefly notices 'New Sources of Light and of Röntgen Rays.' Under Discussion and Correspondence, Charles D. Walcott tells of 'Washington as an Explorer and Surveyor,' while the thanks of the many are due to 'Physicist', who under the caption 'Science and Fiction' reviews Tesla's recent article in the *Century.*

The Osprey for May, rather belated, begins with part V of 'Birds of the Road,' by Paul Bartsch, followed by 'Notes on the Habits of the Blue Jay in Maine,' by J. Merton Swain. Theodore Gill gives the third instalment of 'William Swainson and his Times,' which contains some important information regarding his publications. M. A. Carpenter, Jr., describes 'The Chickadee (*Parus atricapillus*) in Eastern Nebraska' and some 'Remarks on Some of the Birds of the Cape of Good Hope,' by Phillip Lutley Sclater is reprinted from *the Ibis.*

SOCIETIES AND ACADEMIES.

TORREY BOTANICAL CLUB.

On May 30, 1900, a meeting was held at Hazelwood, the residence of Vice-President Dr. T. F. Allen, near Litchfield, Conn., subsequent to a field excursion arranged by Dr. Allen in the vicinity of Litchfield, the Club being his guests from May 29th to 31st.

Professor Lloyd called attention to the occurrence of nectaries* on the leaves of *Pteris aquilina.* The glands are found on the rachis, one below the insertion of each pinna, and may be recognized as modified oval areas covered by a dark red epidermis. The color is due to the presence of matter dissolved in the sap, and is

* Described briefly by Francis Darwin in *Jour. Linn. Soc.*, 15 : 407. 1877.

found also in lines running up and sometimes down the rachis from the glands. These are very active during the rapid growth of the frond, their activity ceasing on the attainment of maturity. The secretion, which is very abundant, is formed independently of bleeding pressure, and the fluid is thick and syrupy. So rapidly does it accumulate that one may notice the increase in the size of the drops with a hand lens. The secretion escapes through modified stomata similar in form to the water-stomata of *Tropeolum*. The glandular tissue beneath extends deeply into the cortical mass of the petiole; its cells are small and contain chlorophyll.

Small ants, and one honey-gathering dipterous insect were noticed visiting the glands; none were seen to be gnawed by the insects. As F. Darwin observed, the plant has few natural enemies or none, and the teleological interpretation must be sought in the internal economy of the plant, probably in connection with nutrition. The abundant excretion of sugar may be a carrier of or an accompaniment to the excretion of some harmful substance. It is noteworthy that up to the present time no other Pteridophyte has been reported to be possessed of nectar-secreting organs. The plants on which the observations were made grew near Bantam Lake, Litchfield, Conn.

Dr. Britton remarked on a young tree of the Swamp Spruce, *Picea brevifolia* Peck, found during the day in a sphagnum bog near Litchfield, and stated that this was probably the most southern known station for this species in New England. The short glaucous leaves and nearly glabrous twigs readily distinguish this tree from the Black Spruce, *P. Mariana*.

Mrs. Britton exhibited specimens of the red-flowered Columbine of the Litchfield region, and remarked on its growth in open fields and the pubescent character of the plant, differing in these features from the plant of the vicinity of New York, which inhabits rocky ledges and is nearly or quite glabrous. She noted that the pubescent plant is also abundant in fields on the Pocono plateau of Pennsylvania.

A vote of thanks was tendered to Dr. Allen for his most generous and agreeable hospitality.

N. L. BRITTON,
Sec'y pro tem.

CURRENT NOTES ON METEOROLOGY.

CLIMATE AND THE ICE INDUSTRY.

THE practical use made of nocturnal radiation for the preparation of ice in certain parts of India has long been well known. The method pursued there is to expose shallow porous earthenware dishes filled with water and resting on rice straw, loosely laid in a small excavation on the surface of the ground. When the conditions are favorable, ice is formed in considerable quantities, even when the temperature of the air is 15° or 20° above freezing. A case of a somewhat similar kind is noted by O. H. Howarth, in a paper on 'The Cordillera of Mexico and its Inhabitants,' in the *Scottish Geographical Magazine* for June. In one of the highest valleys in Oaxaca, at an elevation of 8000–9000 feet, a flourishing ice industry was discovered. It is stated that the ground is covered with a large number of shallow wooden troughs, which are filled with water, and during the winter nights are covered with a film of ice of not more than one-eighth of an inch in thickness. This ice is removed in the morning, shovelled into holes in the ground, and covered with earth. Under these conditions the ice consolidates, and is then cut out in blocks and sent down by mules to the towns, where a ready market is found at all seasons.

FROST FIGHTING.

'Frost Fighting,' is the title of Bulletin No. 29 of the United States Weather Bureau, prepared by A. G. McAdie, local forecast official at San Francisco. The question of protection against frost has been very carefully studied by the Weather Bureau officials in California during the past four years, and every effort has been made to forecast coming frosts, and also to investigate the best methods of protection. Mr. McAdie says that "the experience of the past three years warrants the statement that the loss due to frosts in California, hitherto considered unavoidable, can be prevented, and that unless extreme conditions, by which is meant lower temperatures by 5° than have ever yet been experienced in this State, occur, the citrus fruits of California can be successfully carried through the period when frost is likely." The formation of frost is found to be very largely a matter of air drainage, and every owner is urged to make a detailed study of the movement of local air currents in his own district. Various methods of protection are briefly described, including those based on mixing the air; warming the air; cloud or fog formation; irrigation; spraying, and screening. A 'warm water method,' adopted by Mr. E. A. Meacham, of Riverside, Cal., by which water, after being heated in a small boiler, is allowed to run in furrows through the orchard, is stated to have been successfully tried. The *Bulletin* contains a weather map showing the pressure and temperature conditions which are followed by heavy or killing frosts within 12 hours in southern California, and also gives plates illustrating the different methods of protection.

R. DeC. Ward.

Harvard University.

SCIENTIFIC NOTES AND NOTES.

Harvard University has conferred its LL.D. of Dr. W. H. Welch, professor of pathology in the Johns Hopkins University.

The University of Cracow has conferred an honorary degree on Professor Simon Newcomb, U. S. A., on the occasion of the celebration of its five hundredth anniversary.

The Paris Academy of Sciences has elected Professor L. Boltzmann a corresponding member in the place of the late Professor Beltrami.

We regret that we are unable to secure or to find in any of our exchanges any account of the third biennial conference on an International Catalogue of Scientific Literature beyond the fact that the delegates had a dinner.

By the action of the Massachusetts Senate on June 28th there will be no appropriation this year for the destruction of the gypsy moth.

It is proposed to celebrate the 70th birthday of Professor Wilhelm Wundt, which will occur on the 16th of August, 1902, by the publication a *Festschrift*, to which his former students are invited to contribute. The manuscripts must be forwarded to Professor Külpe, Würzburg, not later than January 1, 1902.

The directorship of the Paris Natural History Museum, vacant by the death of Professor Milne-Edwards, has been filled by the appointment of Professor Edmund Perrier.

Dr. Alfred Goldsborough Mayer, assistant of Mr. Alexander Agassiz, and in charge of Radiates at the Museum of Comparative Zoology, Cambridge, has been appointed curator of the Department of Natural Science in the Museum of the Brooklyn Institute of Arts and Sciences. He will assume his new position in September.

Sir George F. Hampson, Bart., who accepted an invitation to become an assistant in the Insect-room of the British Museum five years ago, has just been promoted to the post of first-class assistant, under a treasury regulation to which we have recently referred. He is the only assistant in the Natural History section of the museum to whom the benefits of this regulation have as yet been extended. But since there are many of his colleagues, men of equal reputation, who have served in the second class for twice, if not thrice, as long, it is anticipated that this good example will soon be followed. It is pleasing to find that after all, the Trustees of the British Museum are able to recognize exceptional merit, when they have special facilities for becoming personally acquainted with it.

The Geological Society of London has elected Professor Paul Groth, of the University of Munich, a foreign member, and Professor A. Issel, of Genoa, a corresponding member.

The Society of Arts has awarded its Albert medal for the present year to Mr. Henry Wilde, F.R.S.

The third of the biennial Huxley Lectures, founded in commemoration of the late Professor Huxley in connection with the Charing Cross Medical School, will be delivered by Lord Lister, President of the Royal Society, on Tuesday, October 2d.

Lord Avebury has been elected president of the Royal Statistical Society. The Society announces as the subject for its Howard medal 'The history and statistics of tropical diseases with special reference to the bubonic plague.'

We regret to record the death of Dr. Willy Kühne, professor of physiology and director of the Physiological Institute of the University of Heidelberg, at the age of 62 years; of Dr. Reinhold Hoppe, docent in mathematics in the University of Berlin, aged 84 years, and of M. Bontain the French physicist.

IT is proposed to erect a monument in Simonstown in memory of the late Miss Mary Kingsley, the African explorer and botanist, who died of fever while engaged in nursing the Boer prisoners.

THE United States Civil Service Commission announces that on July 24, 1900, an examination will be held for the position of assistant ethnologist in the Smithsonian Institution at a salary of $50 a month. The examination will be chiefly on Indian languages and especially on Siouxan languages.

ON August 14th, there will be an examination for the position of assistant, Division of Entomology, Department of Agriculture, at a salary of $840 per annum. The examination will be on entomotaxy and especially on the orthoptera.

A MEETING of the Anatomical Society of Great Britain and Ireland was held at Owens College Manchester on June 21st and 22d.

IT is stated that there has been a meeting of cardinals and other ecclesiastical dignitaries at the Vatican to discuss the expediency of taking an active part in the movement for the prevention of tuberculosis.

AT the Blue Hill Observatory on June 19th a kite used in the exploration of the air was sent to the height of 14,000 feet, which exceeds the greatest height previously obtained there by 1440 feet. The temperature at this height was 15 degrees below the freezing point, the wind velocity was about 25 miles an hour from the northeast, and the air was extremely dry, although clouds floated above and below that level. The kites remained near the highest point from 5 to 8 p. m. They were then reeled in rapidly by a small engine. On the way down they passed through a stratum of thin ragged clouds at the height of 1½ miles. These were moving with a velocity of about 30 miles an hour. At this time the wind at the observatory, about 600 feet above the general level of the surrounding country, had fallen to a calm. The highest point was reached with 4½ miles of music wire as a flying line, supported by 5 kites attached to the line at intervals of about three-fourths of a mile. The kites were Hargrave or box kites of the improved form devised at the Observatory. They have curved flying surfaces modeled after the wings of a bird. The three kites nearest the top of the line had an area of between 60 and 70 square feet each, and the 2 others about 25 feet each. The total weight lifted into the air, including wire, instruments and kites, was about 130 pounds. This flight was one of a series being carried on by Messrs. Clayton, Ferguson and Sweetland. On June 18th the kites reached a height of 11,500 feet. They were sent up a second time the same evening and remained throughout the night at a height of nearly 10,000 feet. At this height the temperature remained from 5 to 10 degrees below freezing.

THE *Philadelphia Medical Journal* reports that the plague is increasing in Australasia. Many cases are reported in Victoria, which probably started in the slums of Melbourne. In the city of Sydney, 239 cases have been reported, with 82 deaths. The extension of the plague to Sydney has caused much disturbance to business. The number of cases is rapidly increasing, in spite of the efforts at destruction of rats and disinfection. The government distributes free to all householders a special rat-poison and sends men to remove dead rats. About 8000 persons have been inoculated with Haffkine's prophylactic. A few days later two or three of those inoculated were attacked by the disease. Dr. Tidswell, the bacteriologist of the New South Wales Health Department, is said to have found plague-bacilli in the alimentary canal of fleas taken from plague-infected rats. The *British Medical Journal* reports 100 deaths daily in Calcutta, and the total mortality is double that number. The local government interferes as little as possible with the domestic affairs of the people. No pressure is used to send cases to the hospitals and many remain untenanted. This system has one advantage—that it does not cause a panic and consequent flight of a large portion of the inhabitants, which would result in spreading the disease over the province. On the other hand, no decrease of the disease in the city can be expected to follow such measures, and it is not surprising that the usual annual increase is greater this year.

UNIVERSITY AND EDUCATIONAL NEWS.

The total amount of the bi-centennial fund of Yale University is now $1,090,000. This sum includes $490,000 subscribed or pledged unconditionally to the general building fund; $250,000 pledged conditionally in case three additional subscribers can be found to give $100,000 each, thus making possible the carrying out of the building plan and $350,000 given or pledged for special purposes other than those of the general building fund. During the year the university has received also the Vanderbilt bequest of $100,000 free of tax; $50,000 from the estate of Charles J. Stillé; $30,000 from the estate of Professor O. C. Marsh, and $15,000 from the estate of Catherine W. Jarman, making, with minor legacies, about $200,000. The University has further just received from Mr. W. E. Dodge of New York City the sum of $30,000 "for the purpose of promoting among its students and graduates and among the educated men of the United States an understanding of the duties of Christian citizenship and a sense of personal responsibility for the performance of those duties." The income of the fund will be paid each year for a series of lectures.

The sum of $109,000 covering the debt of Wellesley College has been raised making available a gift of $100,000 from Mr. John D. Rockefeller.

The daily papers contain a dispatch from Havana regarding an alleged scandal in the University, where some of the best known men in Cuba are said to have received $24,000 a year each as professors. There were 72 of these professors and 24 assistants, some of them having no classes at all and others only one or two students. Many of the professors drew other government salaries. When this was called to General Wood's attention he immediately inaugurated reforms, which resulted in cutting down the list to 46 professors and assistants. So at least runs a cablegram from Havana on which perhaps not very much reliance should be placed.

The United States transport *McPherson*, having on board 231 of the Cuban teachers who will attend the summer school at Harvard University, arrived in Boston harbor on June 30th.

Professor Charles L. Edwards, recently of the University of Cincinnati, was elected on June 26th to the professorship of natural history, in Trinity College, Hartford. The new Hall of Natural History, just completed at a cost of $60,000, is a building of three stories above a high basement, and is designed for the various needs of biology and geology. There are suites of laboratories for anatomy, physiology, experimental morphology, zoology, botany and geology, together with a vivarium. The southern half of the building, provided with a large central light well extending from the first floor to the arched roof, is the museum. The already valuable collections of Trinity College, including the Ward series of invertebrates, vertebrate skeletons and Blascke models will be largely augmented in the near future. Professor Edwards will supervise the equipment of the laboratories during the summer.

The following appointments are also announced: H. T. Cory, a graduate of Purdue University, now in charge of the engineering courses in the University of Missouri, professor of civil engineering in the University of Cincinnati; Dr. Franz Pfaff, assistant professor of pharmacology and therapeutics of the Harvard Medical School; Dr. L. E. Dickson has resigned his position as associate professor of mathematics in the University of Texas, to accept a call to the University of Chicago; Dr. Grace N. Dolson, a graduate of Cornell University, has been made professor of philosophy at Wellesley College; at Princeton University, Professor E. O. Lovett has been promoted to a full professorship of mathematics, and Mr. A. A. H. Lyba has been called to a professorship of mathematics at Roberts College, Constantinople; Dr. George V. N. Dearborn has been appointed assistant professor of physiology in the Tufts College Medical School. He succeeds Dr. Albert P. Mathews, who has been called to an instructorship in physiology in the Harvard Medical School.

SCIENCE

Friday, July 13, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ON KATHODE RAYS AND SOME RELATED PHENOMENA.**

I.

Among the branches of physical investigation that have recently shown especial activity, few occupy a more prominent position at the present time than those that are related to the electrical discharge in rarefied gases. This is true not only because of the rapid development of the subject, but also because of the far reaching importance of the results, and the influence which they seem destined to exert upon widely different branches of physics. When I learned that I was to have the privilege of addressing you to-day, it appeared to me that I could not better utilize the opportunity than by briefly recalling the progress in this subject during the last few years, and calling attention to some of the results that we may reasonably hope for in the future. The whole subject of vacuum tube discharge is, of course, too large to be treated in the brief space of an hour. I shall therefore confine myself to one of its more important subdivisions, namely, the phenomena and theory of the kathode rays.

Of the many beautiful and interesting phenomena that accompany the electrical discharge in rarefied gases, certainly none has attracted such widespread attention as

* Address of the Vice-President and Chairman of Section B (Physics) of the American Association for the Advancement of Science, given at the New York meeting.

the kathode rays. Since their discovery by Plücker in 1859, and the first systematic study of their properties by Hittorf and Crookes, the importance of a more complete understanding of their nature has been generally recognized, and many eminent physicists have made them the subject of extended experimental investigation. In consequence, our knowledge of the kathode rays has progressed during the last few years with startling rapidity. To make clear how great the progress has been, let us consider first the condition of the subject of 1890, at which time the theory of vacuum tube phenomena was just beginning to take systematic and consistent form.

Almost from the time of the first discovery of the kathode rays, widely different opinions had been held regarding their nature. According to one view, the kathode rays were to be regarded as disturbances in the ether, propagated in a manner somewhat analogous to that in which light is transmitted. The rays were not considered as essential to the passage of the current, but as a secondary phenomenon, produced by the discharge. Hertz, for example, suggested that the production of the kathode rays by the discharge in a vacuum tube is analogous to the production of light by the ordinary arc discharge in air. This view furnished a ready explanation of most of the observed phenomena, such, for example, as the rectilinear propagation and diffuse reflection of the kathode rays, and the thermal, mechanical, and luminous effects produced by them. The explanation of the well-known deflection of the rays in passing through a magnetic field was, however, a matter of greater difficulty. I am not aware that a thoroughly satisfactory explanation of this phenomenon, based upon what may be called the ether theory of the kathode rays, has ever been proposed.

The theory proposed by Crookes in 1879, and which usually bears his name, differed radically from that just mentioned. By Crookes and his followers the kathode rays were thought to consist of a stream of negatively electrified particles projected at high velocity from the negative electrode. Such particles would naturally travel in straight lines; upon colliding with solid obstacles their energy would be transformed into that of heat, light, or visible motion; and when moving across the lines of force of a magnetic field they would be deflected from their straight path. The theory of Crookes possessed the great advantage of being concrete and definite, while, at the time the theory was proposed, it was in qualitative agreement with practically all the observed phenomena.

The work of later experimenters, however, had in many instances tended to discredit the theory of Crookes. Thus, the various mechanical effects produced by kathode rays, such as the rotation of radiometer wheels and the like, were found to be due largely, if not wholly, to secondary causes, such as the heat developed by the rays, and the varying static charges on the walls of the tube. Again, if the rays consist of negatively electrified particles, we should expect a conductor placed in their path to acquire a negative charge. Experiments made to test this question were contradictory, but in the majority of cases it was found that the charge was *positive* instead of negative.* Electrified particles moving at right angles to an electrostatic field should be deflected from their straight course; but experiments made by Hertz † and others to detect such an electrostatic deflection gave only negative results. Since the kathode rays are deflected in passing through a magnetic field, we should expect these rays, if they consist of material par-

* Crookes, *Phil. Trans.*, 1879.

† Hertz, *Wied. Ann.*, 19, p. 782, 1883.

ticles, to react upon the field and exert a force tending to move the magnet to which the field is due; no such reaction could be detected.* Many other instances might be cited in which the results of observation were apparently in direct contradiction with the Crookes theory.

Such, in brief, was the condition of the subject at the beginning of the present decade. Of the two theories that had been proposed, each possessed strong arguments in its favor. Neither was free from serious objection.

Previous to this time, very little work of a quantitative nature had been done in connection with the kathode rays, although several estimates had been made of their velocity. Thus, according to Spottiswood and Moulton† the velocity was considerably less than that of light; whole Goldstein‡ had reached the conclusion that the velocity was greater than one four hundredth of the velocity of light. In 1894 a direct determination of the velocity was made by J. J. Thomson§, the method being to observe two fluorescent spots, produced by the kathode rays at different distances from the kathode, by means of a revolving mirror. The result obtained was 2×10^7 cm. per second, or about one thousand times less than the velocity of light. This velocity is practically the same as that which would be acquired by a hydrogen ion repelled from the kathode. Thomson's result therefore supported the view, previously expressed by Schuster, that the kathode rays were not composed of particles of metal torn loose from the electrode, or of charged molecules of the residual gas, but that they consisted of a stream of ions such as occur in ordinary electrolysis.

Recent determinations of the velocity of the kathode rays have shown that the value obtained by Thomson was too small, so that the conclusions based upon it were incorrect. Nevertheless, I am inclined to think that they served a useful purpose. For by directing attention to the discredited emission theory, and to the probable electrolytic nature of gaseous conduction, they stimulated investigation and contributed to the advance of the subject.

The more modern phase of our subject properly begins in 1892, when it was discovered by Hertz* that the kathode rays were able to penetrate thin sheets of gold foil, aluminium, and glass. Taking advantage of this discovery, Lenard in 1893† constructed a vacuum tube containing a small opening covered with aluminium foil, through which the rays passed out into the open air, or into a second tube. It was thus possible to study the rays under conditions which could be readily varied, while the conditions under which the rays were developed remained unaltered. This form of apparatus not only made possible a more systematic study of the known properties of the kathode rays, but also led to the discovery of many new phenomena. Thus, in air at ordinary pressures, the rays were found to discharge electrified bodies, to develop ozone, and to give an impression upon a photographic plate. The photographs published by Lenard, showing the opacity of glass and quartz to these rays, and the comparative transparency of the metals, are strikingly similar to those since obtained with the X-rays. In fact, it now seems probable that X-rays were present to some extent in all Lenard's experiments, and that the phenomena observed by him were in part caused by them.

One of the first questions investigated by Lenard was the influence of the medium through which the rays passed upon their

* Hertz, l. c.

† *Phil. Trans.*, 171, p. 627, 1880.

‡ Goldstein, *Wied. Ann.*, 12, p. 101, 1880.

§ Thomson, *Phil. Mag.*, 38, p. 358, 1894.

* Hertz, *Wied. Ann.*, 45, p. 28, 1892.

† Lenard, *Wied. Ann.*, 51, p. 225, 1894.

intensity and magnetic deflection.* In passing through the air or other gases the rays were observed to suffer diffusion similar to that experienced by light in a turbid medium. It was found that the absorption and diffusion of the rays were approximately proportional to the density. The magnetic deflection, on the other hand, was independent of the medium in which the rays were observed, and remained the same even after the rays had passed through thin sheets of metal.

By changing the conditions under which the rays were generated, different kinds of kathode rays were obtained, whose penetrating power and susceptibility to the action of a magnetic field could be varied through a wide range. Thus, upon reducing the pressure in the tube where the rays were developed, the penetrating power of the rays was found to increase, while at the same time the magnetic deflection became steadily less. In connection with this work Lenard called attention for the first time to the so-called 'magnetic spectrum' of the kathode rays† a phenomenon which was rediscovered by Birkeland ‡ in 1896 and has since attracted considerable attention. It appears that a beam of kathode rays is ordinarily not homogeneous, but that it consists of rays which are magnetically deflected in different degrees. In consequence, the fluorescent patch produced by such a beam, after passing through a magnetic field, is no longer sharply defined. In many cases it is drawn out into an interrupted band, in which regions of bright fluorescence alternate with regions of comparative darkness. The resemblance to a banded or bright line spectrum is often quite striking. The phenomenon is now known to be due to the employment of a fluctuating or interrupted current in developing the rays.* Since the character of the kathode rays is so largely dependent upon the conditions under which they are developed, it is natural to expect that when these conditions are unsteady the rays obtained will be non-homogeneous. If the rays are developed by a steady current, the magnetic spectrum is reduced to a single bright line.

Without stopping to discuss further the interesting and important phenomena investigated by Lenard, let us consider for a moment the bearing of his work upon the two opposing theories of the kathode rays. Upon the assumption that the rays consisted of some sort of wave motion, all Lenard's results were readily explained. That such waves should pass through air, and even through thin layers of metal, was to be expected; the same is true with ordinary light. To explain the diffusion of the rays, it was sufficient to assume that the wave length was small compared with the dimensions of a molecule. The same assumption explained the observed relation between absorption and density. The difficulty in accounting for the magnetic deflection of the rays still remained. But this difficulty was no greater than it had always been, and seemed by no means insurmountable.

On the other hand, to interpret Lenard's results in accordance with the Crookes theory, in the form that it then took, was a matter of great difficulty. That excessively short waves should be able to pass through metal is reasonable enough; but that atoms or molecules should be able to pass is hard to believe. Yet, according to Lenard's experiments, not only must these atoms pass through a grounded sheet of aluminium, carrying with them their electric charge, but they must emerge from the other side with their momentum sensibly unaltered. The suggestion was indeed made by the advocates of the Crookes the-

* *Wied. Ann.*, 52, p. 23, 1894; 56, p. 255, 1895.

† *Wied. Ann.*, 52, p. 32, 1894.

‡ *Comptes rendus*, 123, p. 492, 1896.

* Strutt, *Phil. Mag.*, 48, p. 478, 1899.

ory that the rays did not really penetrate Lenard's aluminium window, but that they made of it a secondary kathode, which sent out new rays of its own into the region beyond.* But the objections to this view are numerous. For example, it is remarkable that the secondary rays should be *exactly* similar in their properties to the rays which produced them, regardless of whether the secondary kathode is thick or thin, a conductor such as aluminium, or an insulator such as glass. Again, Lenard obtained these rays both in air at ordinary pressures, and in a vacuum so high that no discharge could be made to pass. In neither case can kathode rays be produced by any other known method. Is it not strange that a secondary kathode, forming part of a grounded metal inclosure, should not only develop these rays under conditions where all other methods fail, but that it should also produce rays of the same kind and intensity under such widely different conditions? These and other objections make it seem highly unlikely that the Lenard rays can be satisfactorily explained by treating the aluminium window as a secondary kathode. In fact, I think that this view has now been very generally abandoned. But even if it were accepted as correct, the difficulties in the way of the Crookes theory still remained. For if the kathode rays consisted of charged atoms, as had been indicated by the work of Schuster and J. J. Thomson, the fact that they were able to pass through air is scarcely less surprising than that they should penetrate thin sheets of metal.†

Lenard himself interpreted his results as offering additional support to the ether theory, and called attention to the fact that in order to explain the observed phenomena the wave-length must be small compared with the dimensions of a molecule. At the close of his first article in 1894 he says, "Judging by the observed behavior of the gases" (viz, diffusion and absorption of the rays) "the ether phenomena that constitute the kathode rays must be of such extraordinary fineness that dimensions as small as those of molecules have to be taken into consideration. Even toward light of the shortest known wave-length, matter acts as though it were continuous. But toward kathode rays, even the elementary gases behave like non-homogeneous media; each individual molecule seems to form an obstacle to their propagation. Analogous phenomena are observed when ordinary light passes through a medium made turbid by suspended particles."

When we consider the condition of the subject at that time, Lenard's conclusion that the rays must consist of something analogous to wave motion seems most natural. From our present standpoint, however, it is seen that his results might be equally well explained by a modification of the Crookes theory. The same difficulties that are surmounted by the assumption of extremely short waves can also be removed by the assumption of extremely small particles. If the kathode ray particles are only small enough, they might pass for a considerable distance through air, or even through metal films; upon colliding with the molecules of a gas they would rebound in all directions, and diffusion would result; and both diffusion and absorption would be roughly proportional to the density of the medium. But this requires that particles of matter should exist which are small as compared with atoms. The suggestion is a startling one, and so violently contradicts our ordinary views of the constitution of matter that it cannot be accepted without strong support. It is not surprising, therefore, that several years

* J. J. Thomson, 'Recent Researches in Electricity and Magnetism,' p. 126. 'Discharge of Electricity through Gases,' p. 190.

† See J. J. Thomson, 'Discharge of Electricity through Gases,' p. 196.

elapsed after the discovery of the Lenard rays before this modification of the Crookes theory was proposed.

In 1895, about a year after the publication of Lenard's results, came the discovery of the X-rays by Röntgen. The widespread interest which this discovery aroused is fresh in the minds of all of us, and is probably without a parallel in the whole history of physics. Apart from their importance from a purely scientific standpoint, and from their sensational features, the X-rays occupy a unique position among the phenomena connected with the electrical discharge in vacuum tubes; for they afford the first instance in which the scientific results obtained in this branch of physics have been made directly useful in everyday life. Although it is not the purpose of the pure scientist to seek directly such applications, yet every instance of this kind is always a source of gratification. Each new case serves to strengthen that belief which forms the real basis of scientific investigation; the belief that every advance in our knowledge of natural law, be it ever so small, or ever so removed in appearance from the affairs of everyday life, must ultimately contribute to the increase of human happiness and the progress of mankind.

The discovery of the X-rays served to stimulate investigation along all related lines. Interest in the phenomena of the electrical discharge through gases, and especially in the kathode rays, became stronger than ever before; for it was natural to expect that the puzzling problem of determining the nature of the Röntgen rays might be simplified by a better understanding of the kathode rays that produced them.

The numerous difficulties and apparent contradictions which had stood in the way of the adoption of the Crookes theory have already been referred to. These may be said to have culminated with the discovery of the Lenard rays, and the theory in its earlier form was of necessity abandoned. But since that time the difficulties have been one by one removed. Thus, in 1896, it was shown by Perrin* that the kathode rays really do carry a negative charge; this conclusion was confirmed by J. J. Thomson† in 1897. That a negative charge is also carried by the Lenard rays was afterwards shown by McClelland,‡ Wien,§ and Lenard.|| By passing the rays through an aluminium window in a completely closed metal box, Lenard was able to give a negative charge to an insulated conductor within. Certainly a more conclusive proof that the kathode rays are electrified can hardly be demanded.

The deflection of the kathode rays in passing through an electrostatic field, which the Crookes theory required, and which Hertz had looked for in vain, was proved to exist by Jaumann ¶ in 1896, and much more conclusively by J. J. Thomson ** in 1897. A year later it was shown by Wien †† and Lenard ‡‡ that a similar electrostatic deflection occurred in the case of the Lenard rays.

Not only were the earlier experiments shown to be in error in both these cases, but the reasons for their failure are now pretty well understood. Probably the most important sources of error were due to the fact that the residual gas in a vacuum tube is rendered conducting by the discharge. The kathode rays also exert a special ionizing influence of their own, so that in those parts of the tube which are traversed by these rays, the gas becomes temporarily a good conductor. In consequence it acts

* Perrin, *Nature*, 53, p. 298, 1896.

† Thomson, *Phil. Mag.*, 44, p. 293, 1897.

‡ McClelland, *Lond. Elect.*, 39, p. 74, 1897.

§ Wien, *Wied. Ann.*, 65, p. 440, 1898.

|| Lenard, *Wied. Ann.*, 64, p. 279, 1898.

¶ Jaumann, *Wiener Berichte*, 105, 2a, p. 291, 1896.

** Thomson, *Phil. Mag.*, 44, p. 293, 1897.

†† Wien, *Wied. Ann.*, 65, p. 440, 1898.

‡‡ Lenard, *Wied. Ann.*, 64, p. 279, 1898.

as a conducting screen, which protects the rays from electrostatic influences. This explanation of the failure to obtain electrostatic deflection was suggested by Schuster * as early as 1890; but the importance of this source of error was not generally appreciated until much later. The fact that a conductor placed in the path of the kathode rays usually takes a positive charge instead of a negative one is doubtless due to the same cause. Being surrounded by a conducting medium, the conductor will receive its charge partly from the kathode rays and partly by induction. The inductive charge will usually be positive, and may be sufficiently strong to determine the sign of the resultant. Doubtless the almost universal employment of the induction coil by the earlier observers was also in part to blame for the contradictory results. The use of a fluctuating current is now seen to introduce many annoying complications. In quantitative work especially, some source of steady current, such as a large Holtz machine or a storage battery, is much to be preferred.

The discovery that the kathode rays carry a negative charge and are subject to electrostatic deflection afforded so strong an argument in favor of the Crookes theory, that attempts were at once made to subject the theory to quantitative tests. The question of the size of the kathode ray particles and the charge carried by them was attacked independently and almost simultaneously by Wiechert† and J. J. Thomson.‡ It is interesting to observe that although the conclusions reached were practically the same, the methods employed were radically different. Wiechert's first determinations were based upon the consideration that since the motion of the kathode ray particle is due to the electrical forces, the kinetic energy acquired by each particle must be equal to the potential energy which it possessed at the surface of the kathode. A relation is thus obtained connecting the charge, mass, and velocity of the particles with the potential of the kathode. A second relation between these same quantities is obtained by measuring the deflection of the rays in a magnetic field of known strength. By elimination it is then possible to determine both the velocity of the rays and the ratio of the charge carried by each particle to its mass. The results indicated a velocity not far from 10^{10} cm. per second, or nearly one-third that of light. That a material particle should move at such an enormous velocity seems almost incredible. It is not surprising that Wiechert felt the need of checking this result by some independent method. He did so by employing a method that had been suggested by Des Coudres* in 1895, and which is independent of any assumption regarding the nature of the kathode rays; the results obtained were of the same order of magnitude as before. That the kathode rays often have a velocity closely approaching that of light has since been abundantly confirmed.

Wiechert's values for the ratio e/m—*i. e.*, the ratio of the charge carried by a kathode rays particle to the mass,—lay between 20×10^6 and 40×10^6 (c. g. s., electro-magnetic units). This is about three thousand times greater than the corresponding ratio for the hydrogen ion in ordinary electrolysis. We must therefore conclude either that the particles carry a much larger charge than is carried by an ion in electrolysis, or else that they are smaller than the hydrogen atom. The latter alternative, which harmonizes so well with the

Proc. Roy. Soc., 47, p. 526, 1890.

† Physikal.-ökonom. Gesellschaft in Königsberg. Jan. 7, 1897. *Wiedemann's Beiblätter*, 21, p. 443.

‡ Royal Institution Lecture. April 30, 1897. *Lond. Elect.*, 39, p. 104, 1897. *Phil. Mag.* 44, p. 293, 1897.

* *Wiedemann's Beiblätter*, 21, p. 648.

phenomena of the Lenard rays, is the one usually accepted.

The value of e/m was determined by two entirely different methods by J. J. Thomson, the results being published at practically the same time as those of Wiechert. In the first method used by Thomson, the kinetic energy of the particles was determined by measuring the heat developed when the rays fell upon the face of a thermopile, and the charge carried by them was measured by an electrometer. These two measurements, together with the magnetic deflection in a known field, make possible the computation of both e/m and v. The values of e/m obtained in the most reliable experiments by this method ranged from 14×10^6 to 10×10^6. The corresponding values of the velocity were about one-tenth the velocity of light. The second method, which is regarded by Thomson as more reliable, involved the determination of the electrostatic deflection in a known electric field, and the magnetic deflection of the same rays in a known magnetic field. This method gave values of e/m ranging from 9×10^6 to 6.7×10^6, the velocity being about one-tenth that of light, as before. Thomson found that the ration e/m was independent of the nature of the gas in the tube. This result has been confirmed by Kaufmann,* who found that the ration was also independent of the material of the kathode.

The conclusions naturally drawn from these results may be put into the following crude and provisional form: The kathode rays consist of negatively charged particles, or corpuscles, which are much smaller than the atom of hydrogen. These corpuscles are present as a constituent part of the molecule in all substances: whether only one such corpuscle is present for each molecule, possibly revolving about it like a satellite, or whether each molecule consists of an aggregation of corpuscles, it is not yet possible to say. Under the influence of the intense electrical field at the negative terminal of a vacuum tube, the corpuscles are in some cases freed from the forces that hold them to the remainder of the molecule, and shoot off at enormous speed to form the kathode rays.

* *Wied. Ann.*, 61, p. 545, 1897.

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(*To be concluded.*)

SOME TWENTIETH CENTURY PROBLEMS.*

IT is never a bad plan to improve an anniversary occasion by comparative observations. In commercial and manufacturing lines, short intervals of time are marked by balancing books and checking off accounts, and an inventory is taken at the end of the year without exception. And so it happens that I am going to recognize to-day the fact that we stand at the end of a century, and what I have to say will be influenced to no small extent by the recognition of that fact.

Under ordinary circumstances, with this in mind, I could hardly avoid following the commercial example at the end of the year, and taking an account of stock, balancing accounts, and ascertaining the advance or retrogression in our branch of the scientific world during the period of time that represents three generations of human beings. I do not intend, however, to do this, partly because I do not wish to weary an audience with all that ought to be passed in review in such an important anniversary summation, and partly because, a few years since, Professor H. Marshall Ward, in resuming the botanical progress of the Victorian Era, gave the more important facts, while the vice-presidential addresses of several recent years before this Section have dealt with important advances in botanical thought in

*Address of the Vice-President, Chairman of Section G (Botany) of the American Association for the Advancement of Science, given at the New York meeting.

different directions, and of the progress of the early part of the century Sachs has given a sufficient epitome. I propose, therefore, that we shall consider the inventory and balance sheet as in hand, and that, like the thoughtful business man who has closed his books for the year after noting what he has on hand and what the balance sheet shows, we shall take a general view of the situation, in the hope that some hint of economy or conservatism or changed method may suggest itself as we do so, by which the work of the new century may be furthered.

I have felt some interest in looking over the present trend of botanical thought, as evidenced in a few recent journals and in the advance programs of this Association and the affiliated societies devoted to subjects in which botany figures directly or indirectly. Neglecting strictly economic botany, I observe that taxonomy and descriptive botany lead (42 per cent. in the particular examination made), followed at some distance by morphology and organography (25 per cent.) and physiology and ecology (20 per cent.), while the much smaller remainder (13 per cent.) consists in nearly equal parts of vegetable pathology, phytogeography and floras, and the evolution of plants either in a state of nature or under the hand of man. Though the percentages may vary considerably, the general distribution indicated above would probably apply in the main to the prevalent activity of purely botanical research.

A hasty scrutiny of not far from a thousand periodical publications received at the library of the Missouri Botanical Garden, and all containing at least occasional articles on pure or applied botany, shows, as might be expected, that the percentage of journals restricted to one branch of botany is much smaller than the average percentage contents of the current journals or programs. Even where botany is largely or exclusively represented, the contents of journals are usually very heterogeneous. Notes or longer papers on local floras or on the characters of one or a few species largely preponderate, and there are only a few journals which concern themselves entirely or chiefly with any other single component of botanical knowledge. Among these, vegetable pathology, and economic botany in one or other of its subdivisions, assume a comparable position with morphology and physiology, though, for the reasons stated, all are relatively lowered with reference to taxonomy, as compared with current papers included in the journals. Phytogeography and evolutionary matters appear to be more suitable for books than the other main subjects excepting floras, and they do not appear to have led as yet to the establishment of journals specifically devoted to them.

The preponderance of taxonomic work as indicated by publications calls for a little consideration. Human interest in plants, as in nature generally, appears to have begun in most cases by the observation of useful and injurious or mysterious things; but before the information of the individual could become public knowledge it was necessary to mark differences between things and to name or otherwise designate them intelligibly. It is therefore natural that taxonomy and nomenclature, in one form or other, and however they may have been designated, should have played an equal part with economic observation in even the earlier studies of plants; and it is not at all surprising that the first real science of botany should have been developed along these lines, nor that the awakening interest in other lines of botanical study should have failed as yet to attain an equal position as regards the number of botanists concerned with them.

It is also a very natural thing that the abstract idea of the distinguishable groups of individuals that have been called species should have been ultimately all but personified, and erected into something supposed to have been realities, divinely established and immutable. Even those of us who have not passed middle age were alive when, as one of my geological friends has expressed it, a Species was treated almost like a thing that had legs and could walk; and even the younger of us have seen the idea grow, from Darwin and Wallace and Huxley and Gray, through the scientific circles into the world at large, that heresy and atheism are not necessarily implied in the belief that existing species are descended from different earlier species, and that their descendants, in all probability, will be considered as yet other species.

If the incident had been closed with a general acceptance of this idea of the mutability of species, we should probably have been spared some trouble which we are now experiencing and which we are actively accumulating for transmission to our followers on the stage; but the change in the theoretical way of viewing the question of species has involved many practical changes in the way of treating them.

In some pliable groups, the expert plant breeder is quite willing to take an order for a non-existent garden form that differs as much from all of the named and classified plants as one species does from another in nature, and, though he may not give a bonded guaranty that it will not revert to some other form after a few years, it is quite likely to transmit its characters for a considerable if indefinite time if bred true, a condition less readily applied in the garden than among species in a state of nature, but scarcely more negligible in the one case than in the other. Whether or not we are to call the most distinct cultivated forms, some of which have been deliberately evolved by the gardener and some of which have originated as sports or sudden variants of either wild or cultivated plants, species, is rather a matter of agreement than anything else, for such as are capable of perpetuation by ordinary natural means constitute, in fact, groups of similar individuals of common origin, reproducing their kind, which is about all that can be said now of natural species.

The growing knowledge of the great and immediate plasticity of species has led to a considerably greater change in the way of viewing them in the abstract than even that which the introduction of evolutionary views caused. That virtually left them as real concepts, though it opened a vaguely distant question as to their beginning and end; but this brings the beginning and end so close together as to cast doubt upon the existence of species at all as definable groups having any considerable stability in time.

I can distinctly recall the thrill of surprise with which, in my student days, I heard of the belief of a distinguished German professor, that species as known in other plants and animals probably did not exist among the bacteria. I felt grateful later that the American flora contains fewer representatives of *Hieracium* than are found in Europe, when I saw the desperate efforts that the Germans have made to distinguish these difficult plants; and the polymorphism of the European brambles made apparent equal reason for thankfulness that American institutions are simpler also in that genus. But the rehabilitation of synonyms and varieties in all groups that the last decade has witnessed, and the increasing rapidity with which the species-splitting knife is falling upon *Antennaria*, *Sisyrinchium*, *Viola*, *Cratægus* and many other genera, have removed any such misguided thankfulness, and the further separability of natural plants, even on the old lines of specific delimitation, appears to be coming into as strong evidence on the one hand as the gardener's power to create equally distinct species or races is on the other.

There are several ways in which these admissions may affect our judgment and actions. Recognition of measurable parallelism between the operations of nature and of the gardener goes far toward removing a sentimental objection to considering as species the forms which the latter brings into being, but the treatment of both natural and garden forms on a uniform basis is likely to modify the extreme treatment which would otherwise be accorded to either. The garden forms of a given type of plant are often so numerous and so freely subdivisible as to threaten, when this is carried out, either a very undesirable polynomial nomenclature or, what is worse, the multiplication of barely separable genera, in order that the facts may be fully expressed. It is evident that too great a multiplication of genera can but result in unwieldy complexity of system, and it is equally evident that, the ultimate purpose of the systematist being to classify and describe for others the plants which actually exist—whether in the woods or the garden—he must not be content with distinguishing between the more easily separated only, but must provide for all of the forms which either the botanist or the gardener or the user of plants for manufacturing and other purposes needs the means of separating.

We are living through a transition period in our science, and should not close our eyes to the practical meaning of the changes in our beliefs. We are carrying on a movement for so classifying all groups of plants as to indicate their phylogeny by their position—or, otherwise stated, we are continuing the effort of our predecessors to secure a natural system based on real affinity rather than superficial resemblance—and at the same time we are beginning to recognize that the groups of individuals that we call species are of every-day value only in proportion to their simplicity and definability. Two years ago Dr. Farlow made a strong statement of the necessary utilitarian trend of the present attitude with respect to species. My own belief is that this will very shortly become a principal guiding thought in the work of all describers of plants, and that the old idea of something distinct in nature between the concepts of a species and a variety, which has suffered greatly in the changes that have already come about but is still leading to diverse practices, will be eliminated as a factor of any importance.

In the address referred to, Dr. Farlow likened the efforts of the descriptive botanist to those of the happy possessor of a kodak—snap-shotting the ever changing procession of nature. It is evident that if the facts shown have changed before the picture is developed, the latter can be of value for comparison and as a record of change only; but, fully as we may believe now in the changeableness of species, I think that most of us are convinced from our own experience that the span of human life is relatively short enough to prevent discouragement of the best work of which the taxonomist is capable, if, as we are more and more coming to believe necessary, it be conformed to utility as its first purpose—a purpose not at all inconsistent with phylogenetic expression.

One of the questions of daily growing interest and importance is that of the authentication and preservation of type material in descriptive natural history. It is probably and unfortunately true that many more species have been described originally from fragmentary and imperfect material than from adequate specimens, and it sometimes happens that the material of to-day makes possible a very satisfactory synopsis of a genus or family, although the greatest difficulty is encountered in attaching to the different species the names which were originally given to them. This, of course, is particularly true of groups in which specimens are made with difficulty or are easily destroyed, and, as with Myxomycetes, it sometimes becomes almost or quite impossible to go further back in the application of names than some comparatively recent monographer's collections. A growing disposition is noticeable to subject what may be considered type specimens to more restricted use than was prevalent even a few years ago, and it is easy to see that with the daily increasing minuteness of classification, such preservative restrictions are likely to increase rather than diminish as time goes on. In some of the larger collections, the type material is already being removed from the general collections, and type collections are being formed. I have no doubt that a clear recognition of the meaning and importance of types, cotypes, topotypes, etc., as contrasted with ordinary specimens, will ultimately lead to the general adoption of this practice and to a prohibition of the mutilation of such specimens, even for purposes of minute study, as complete, if not as sensational, as that which the sealing of the cases containing Reichenbach's orchid types for a quarter of a century has effected in that family, possibly to the ultimate benefit of science, but certainly to the impairment of the work of to-day. What are to be regarded as types, cotypes and the like, for species, it is not difficult to see in most cases. A more debatable question, which indeed affects all the groups of plants superior to species, in which are to be expected ultimate upheavals quite as far reaching as those which we see to-day in the lower groups, is that referring to the types of genera and still higher groups. This may form the subject of a committee report at this meeting, and it is to be hoped that conservative and sound but far reaching and uniform action may be secured through the efforts of this committee of the Botanical Club, and of the Section.

In the vice-presidential address before this Section a year ago, Professor Barnes, speaking from the point of view of the physiologist, who often finds plants of very diverse physiological behavior pertaining to one species of the taxonomist, expressed the belief that the plasticity of plants, concerning which much has been learned in recent years, is really so great that it is almost impossible, for physiological purposes, to group together any individuals except those growing under identical conditions; and he hazards the suggestion that the present method of naming plants binomially as species must sooner or later give place to some other and radically different method.

The dependence of the morphologist and physiologist upon the taxonomist is indeed quite as great as that of the student of geographical distribution and the cultivator of plants, and any classification and nomenclature which are to persist as of permanent value must of necessity be alike useful to all who are interested in plants, from whatever point of view. Whatever value the studies of morphologists and physiologists possess to-day comes from co-ordination and generalization in the light of the existing classification of plants, and the future development of these studies is most intimately connected with the evolution of a system of classifying and naming plants which shall at once permit of the ready determination and intelligible designation of any desired group of comparable plants, —a result that alone can avert the very possible danger of a scattering of energy in the accumulation of information concerning untold myriads of individuals, the peculiarities of which, however much they may interest and occupy the student, can scarcely enter into science until co-ordinated and generalized on rational and reasonably permanent lines intelligible to all botanists.

The greater part of the species and varieties that pass the necessarily fine-meshed sieve of to-day are published and defined apart from their nearest relatives, so that their authors are commonly spared the difficulty of really arranging them in the system, and it is doubtful if some species which are now being published would really stand in the minds of their authors were the latter compelled to clearly differentiate them in a comprehensive treatment of the genus to which they belong.

Perhaps the most instructive current effort at a logical co-ordination of the groups of high and low degree is afforded by the Synopsis of the Middle-European Flora now being published by Ascherson & Graebner, who treat the broadly defined groups which Linnæus would have called species as 'collective species,' as subdivisions of which they then recognize species, subspecies, occasionally of several degrees, races, varieties, subvarieties and sports. To subspecies as well as species and collective species they give binomial designations, which unfortunately in a few cases, but not as a rule, are identical. A very good idea of the working of this system may be obtained from their treatment of the *Cystea angustata* of Smith, or the *Andropogon niger* of Kunth.

If the need of subdividing the groups of plants which have heretofore passed as species were no greater for any purposes than for the determination of, for instance, the wild plants of the Middle-European flora, it might not be worth while to follow this subject further or to modify a treatment which gives a possible trinomial for any form which the authors have desired to designate, and in the actual synopsis locates this form in its logical position. Unfortunately, however, unless botany for herborizers is to be a thing quite apart from botany for horticulturists, the general monographer of *Cystopteris*, *Athyrium*, *Andropogon*, *Rubus* or *Pyrus* must soon handle a far greater number of forms and subforms of all degrees than have been attempted even in the most comprehensive schemes yet attempted.

Horticulturists are trying to distinguish between their more transient artificial productions, and natural forms or those which are more closely comparable with such forms. For the former they are trying with more or less consistency and real desire to secure the uniform adoption of simple vernacular names, while for the latter, perhaps with equal consistency and earnestness, they are trying to follow the practice of the botanists, so far as they can ascertain what that is. The actual result of this effort is, for instance, to recognize, in the orchard and the market, a variety of Greening apple known as the Rhode Island, to which each farmer's son and each clerk in the commission house receives personal introduction as he would to a new neighbor or a new customer, and the distinguishing marks of which he familiarizes himself with as he would with those of a man whom he might want to know if he were to see him again.

This is not far different from the way in which men made themselves acquainted with herbs and simples before the day of books. It is very good so far as it goes, but it is neither scientific nor adapted to even the present complexity of that theoretical horticulture which every year is finding greater exemplification in practice. To advance on it, the gardener must fall back on the botanist, whose task will be to systematize what the gardener knows and what his own broader knowledge of plants may add. Now the simple matter becomes complicated. *Pyrus Malus*, for example, represents a species or collective species under which many hybrids and varieties now hopelessly jumbled are capable of arrangement in logical combinations, through which, when they shall have been made, the trained student can run down the Rhode Island or the Golden Russet with just as great facility and certainty as he can now determine *Ranunculus septentrionalis* or *Trilliam viridiflorum.* For the garden name of the apple, Rhode Island does very well, but for its botanical designation the Latinized name of the last fairly marked form of *Pyrus Malus*, or whatever the species may be called, is wanted. In the case of *Cystopteris* and *Andropogon*, already referred to, this would be given by either the trinomial *Cystopteris fragilis angustata* or *C. eufragilis angustata*, in the one case, and *Andropogon sorghum niger* or *A. eusorghum niger* in the other; but the actual position of either is indicated only by saying *Cystopteris fragilis eufragilis pinnatipartita angustata*, for the one, and *Andropogon sorghum* (sp. coll.) *sorghum eusorghum obovatus niger*, for the other. I fear that the true expression of the facts in many genera, under the present system, would be likely to result either in a polynomial as long as those used before Linnæus' somewhat arbitrary but masterly and helpful simplification of nomenclature, and without the descriptive value of the old phrases, or in the erection of genera nearly on the lines of the Linnæan species.

Either of these results is unpleasant to contemplate, and we may well inquire if they represent the only possible solutions of the problem of even a much finer specific differentiation than is now prevalent. A generation ago the best botanists would not have looked with favor on a proposal to separate species on as fine lines as the more conservative botanists now see to be logical as well as desirable. Perhaps the botanists of to-day may not be prepared for even as radical a change as the separate nomenclature of collective species, species, subspecies, and varieties has already brought to them; but I am not sure that the botanists of the next generation will not carry out a simplification of the present system —which by that time promises to be most unwieldy—that shall be quite as helpful as that which won Linnæus the gratitude of his followers and which we could not do without in the present state of the science.

I have been tempted to enlarge on this point and to exemplify the idea that I have, by a concrete illustration based on some genus of plants in which the number of minute forms to be distinguished is already very large; but I shall content myself by saying that the idea that I have of such a reform is strongly foreshadowed in the practice already introduced of binomially designating collective species and subspecies as well as species; and it goes so far as the employment of binomials down to one remove from the ultimate subdivisions of cultivated plants designated by vernacular names. For many writers on the broader facts of plant distribution and plant properties, the Linnæan conception of species is and will be sufficient, and alone applicable. For such persons, for instance, the name *Cystopteris fragilis* or *Andropogon sorghum* is satisfactory. The necessary degree of subdivision will always vary according to the particular purpose and knowledge of the writer who may care to go further than this. For one, *Cystopteris eufragilis* will be sufficient; for another, *C. pinnatipartita* or an equivalent binomial; for another, *C. angustata;* while still another may find it desirable to specify by not to exceed a trinomial a subdivision of the latter of perhaps three or four degrees removal. The practical result that I foresee, then, is the ultimate uniform establishment of species of several grades, each binomially designated and its grade, perhaps, indicated by typographical means or the employment of a brief symbol connected with the name, unless, after the present nomenclature storm shall have blown by, as it surely will before this point is reached, it be indicated by the adoption of uniform endings for the specific names of each grade.

I can easily fancy a distinct protest at the violence that any such plan will do to our present treatment of species, and a further and greater protest against the possible modification of prior specific names in the interest of uniformity. A contemplation of the results of the current nomenclature reform makes me share in the feeling which could prompt such a protest, yet I venture to believe that the conservatism which opposed and still opposes the relatively trivial priority upheaval that was to have produced a uniformity in plant names that some botanists are still anxiously awaiting, rests upon qualities that are more likely to favor than oppose a far greater and even radical change in the way of naming plants, when such a change shall have become necessary as a matter of practical utility—as it is likely to sooner than most of us suspect.

One of the most serious tasks of the investigator of the twentieth century will be the utilization of the knowledge resulting from the work of his predecessors in the field which he may select for his own activity. The rapid increase in specialization compels him to begin his own productive studies at an advanced point, while the mass of material and the array of facts over and through which he must clamber before reaching his own starting point constitutes a growing handicap, against the beginner and likely often to discourage him and not infrequently to make him a loser from the start in the race for recognition and fame, but in his favor after he shall once have left it to his followers. Very probably, much that he has learned at the start will have to be unlearned later and no doubt might better not have been learned at all, for it is an unpleasant fact that little progress in any direction is made without the aid and embodiment of theories and hypotheses, many of which of necessity are tentative and sooner or later prove to be wrong, and that few wrong hypotheses fail to leave a long persistent trail of erroneous reasoning and even of observation so badly warped as to be absolutely misleading; but aside from what is faulty, there is being brought together daily an overwhelming mass of information of the greatest use, so that everything must be tested step by step as any piece of investigation proceeds, and the faulty detected and rejected, while the trustworthy is built into the foundation on which the author's own conclusions are to rest.

No doubt after assimilating the principal knowledge of the past, every original and really productive worker would feel a sense of relief if he could wipe out the records of this knowledge. Their existence virtually compels him to burden his own discussion of the subject with an analysis, commendatory or critical, of all that has been said of it by his predecessors,—failing in which, he leaves to those who follow him the conclusion either that he has not considered the facts and deductions of earlier students, or that none exist. The presumptive value of his own work must of necessity be greatly weakened if the first opinion is held, and in the other event he is likely to seem to pose as a leader when to the discriminating eye he is merely a follower.

No small part of the difficulty of reaching the point where one's own additions to science begin comes from the fact that the work of those who have gone before him is commonly fragmentary and disjointed. It is a first principle in research that no accurately observed fact is valueless, but its value lies chiefly in its comparability with other facts. As a rule, thought or observation on any subject stimulates the further elaboration of that subject, by drawing attention to minutiæ which any observant person may then note, though he might not have thought of connecting them himself. Science has been both advanced and retarded by the observation and record of isolated facts,—advanced when observation has been followed by further study and the knitting to it of other pertinent observations or when it has proposed a new line of study awaiting a mind great enough to grasp it, but retarded when straws have merely been added to the burden carried by the world of learning.

The botany of antiquity and of the Middle Ages was chiefly a disjointed discussion of plants, largely with reference to their uses, and not a little mixed with mythology and the fables of travelers, whose talents in our time would have proved invaluable to the daily press. Without disparagement to the great men who went before him, Linnæus may be said to have been the first naturalist whose mind grasped numberless details with sufficient precision to really systematize them, just as in our own century Darwin stands far out from his fellows in the same respect, the power to handle and co-ordinate isolated facts which all his work shows being particularly evident in the treatment of the great mass of heterogeneous matter on which were based his generalizations as to the variations of animals and plants under domestication.

Ours has been a century of accumulation and of utilization. It would be unjust to ourselves and our immediate predecessors to say that great laws have not been reasoned out from observed facts in larger measure even than ever before, notwithstanding the advanced point at which science stood when the century opened. It would be also in obvious conflict with the truth to say that the world of manufactures and of commerce has not been most apt to seize upon and employ the more salient discoveries of science, often in a manner not dreamed of by the discoverers; but it may still be said that the century just closing, great as have been its advances, has been a century of accumulation beyond assimilation, a period of roughing out and of laying away lumber far in excess of its employment as joists and sills and boards in the great structure of human progress.

If the evidence of the times may be trusted, the next century is to be marked by a still greater productive activity. Specialization and the attendant division of labor can have no result more logical than this. Though it may suit our convenience to speak of centuries, we know the pure artificiality of such divisions of time, and although still in the nineteenth century, we may with all propriety count ourselves of the twentieth and project the activities and tendencies of to-day into the morrow; but the same drift of the straws which points to a still greater accumulation of minutiæ during the century we are so soon to enter on shows with equal probability that its passage is to be marked by a co-ordination of isolated observations and discoveries far greater than the world has ever before witnessed.

To this very desirable end we of the present day may contribute to no small degree. Our discoveries, as has been said already, are at once the handicap and the foundation stones of the men who are to take our places. The manner in which we leave the records of what we have done decides in large part the preponderance of its utility over its obstructiveness, and in many cases may even determine whether it might not better have been left undone. It is easy to justify ourselves to a certain extent when we do not do the right thing, by pleading that we did not know what the right thing was, because we interested ourselves only in a limited part of what ought to have been handled as a whole, and that posterity ought to be grateful for the substance of our contributions without being too critical as to their form and accessibility; but we are not likely to go far wrong if we assume that few of us who contribute isolated and disjointed facts and observations will ever be called blessed by coming generations in more than an undertone, that appellation being reserved for those who have builded from as well as hewn out their material, and for those who, even without directly contributing to observed facts, have justly valued the facts ascertained by others and have grouped and shaped and utilized them.

If it could be done within the time that I have proposed to occupy, I should like to consider in detail the entire matter of publication, which is in need of much more thought and concerted action than has yet been bestowed upon it. I fear that the amount of time and thought devoted to the publication of the results of a given piece of research work is often disproportionately small, the fact that they are published at all apparently serving the author's purpose without much regard to the manner in which they are brought out. Publication facilities at one time were few and not readily obtained, but to-day the trouble is rather that they are so numerous and so generally available that even matter unworthy of publication can easily be brought out, and that the authors of meritorious articles are tempted not to look far before publishing their work, but to drop it, hit or miss, into the nearest press, without correlation with other comparable matter or even with the articles to which it stands in juxtaposition, and with too little thought of the convenience of those who are to use it. It sometimes happens, too, that in their zeal they issue simultaneously or otherwise copies of their manuscript to several societies or journals, so that the original place of publication of the article is now and then rendered very questionable.

I should not wish to seem captious in making these statements, for nothing is further from my purpose than destructive criticism; but in view of the growing amount and complexity of scientific publication, I believe that the real needs of the users of botanical literature demand more careful consideration than they have heretofore received, and that this consideration will easily lead to a number of reforms which are perfectly within the power of both author and publisher.

Reference has been made already to the fact that a majority of periodicals are of very mixed contents. So far as societies are concerned, the greater number of these bodies have originated primarily for the development of local interests, and of necessity these interests have been varied. For their own direct purposes, the heterogeneity referred to works very little harm, and for the bibliographer it is the less troublesome because the very condensation of the miscellaneous matter in a local publication places a large part of it where it would naturally be sought. The direct purpose of the publication provisions of nearly all such bodies being not only to secure the permanent recording of observation but to furnish the means of building up a library by way of exchange, it is probable that the partly undesirable mixed contents of the larger number of society publications will continue still for a very long time, but it is encouraging to notice that some of the greater foreign societies have long since differentiated along main lines in their publication, while within recent years a further specialization has been effected in a number of others, notably, for our own country, the California Academy of Sciences, and such differentiation is easily foreseen in others as their membership and activity increase through the formation of sections, each devoted to some particular science, the more strongly represented and active sections being almost certain ultimately to secure the separate publication of their matter.

For the journals which do not emanate from learned bodies, the problem is a simpler one. We already have numerous examples of a primary differentiation into popular and technical journals. The former can hardly fail to be, for the most part, of miscellaneous contents, because they are intended to keep all persons interested in science at large informed on the advances which are being made in its several departments. Familiar illustrations of successful journals of this kind are *Die Natur*, the *Naturwissenschaftliche Rundschau*, *Nature*, *Science Gossip*, *Science*, the *American Naturalist* and the *Popular Science Monthly*, not to mention others of a list which might be greatly extended. Even among these, however, as the examples named may serve to show, there is a considerable specialization on subject lines, and the present issuance of *Science* and the *Popular Science Monthly* under one editorial management may be taken as representative of a process of evolution in active progress, by which even the less technical journals are differentiating into classes adapted to readers engaged in active scientific work and persons having an interest in but not directly engaged with such work.

One further differentiation that is becoming a pressing necessity is that which shall result in a considerable improvement in the specialist's means of keeping himself informed on what has been done in his own specialty. I do not refer to the popular or general presentation of the more striking results of current activity which can be obtained from the general journals or those devoted to each particular branch of science, but to something which of necessity must be limited to that branch and which must be complete. Many of the proceedings of societies and of the journals publish very helpful bibliographies at short intervals, and the *Botanisches Centralblatt* is in large part devoted to this purpose, while the *Jahresbericht*, taking more time than is possible for a current periodical, summarizes and indexes with much greater fullness current botanical literature. Unfortunately, the *Jahresbericht* is so greatly delayed that a period of several years elapses before its pages afford information on any given piece of work, and it is difficult to see how this can be otherwise, in view of the care which is expended in the tabulation and co-ordination of its contents; but without this tabulation and co-ordination, it does not seem to be impossible to secure a very prompt synopsis of all that is issued in botanical literature. The machinery for doing this is already organized in the bureau of the *Centralblatt*, and it is difficult to see why all that is needed cannot be supplied through this channel, if the publishers can be convinced that the botanical public would much rather subscribe for a bibliographic journal, in which all abstracts are of short length and synoptic character, than for one in which many abstracts are entirely disproportionate in length to the importance of the papers they refer to, to the exclusion of others, while the introduction of original matter forces into a supplementary journal no small part of the reviews that are given. Professor Farlow has very well discussed this subject in a recent number of one of the botanical periodicals, and it is hoped that the action initiated at the Naturalists' meeting last winter, which is likely to be brought up by a committee report before this Section, may here find important support, so that either a separation may be secured, of the *Centralblatt* and its *Beihefte* into two journals capable of being subscribed for separately and permitting the desired completeness of bibliography, or other practicable means evolved for attaining this end.

Some years ago, the members of this Association listened with no little interest to Dr. Herbert Haviland Field's explanation of the purposes of his then proposed Concilium Bibliographicum, which has since begun operations in Zürich and I understand is prepared to include botany among the subjects that it handles. It is a matter for regret that the Royal Society's proposal for an international catalogue of current literature has failed to materialize for the time being, but it is possible that if a satisfactory purely botanical bibliographic journal cannot be secured, this scheme can still be put into practical motion. In one way or another, in any event, it is certain that some provision of the kind must be secured within a very few years.

However specialized, publications considered as a whole are in need of far more careful editing than they commonly receive. The author who prepares manuscript for publication is more likely than not to cast it in final form with reference only to what he says in it or what he himself may have already published or may expect to publish at some future time, and the result of this disjointed treatment is perhaps most readily seen when some subsequent compiler, let us say of a popular flora, copies side by side the descriptions of a number of writers. The most diverse phraseology is at once evidenced, although the compiler, on the basis of his own information, may have attempted to simplify the matter somewhat. Comparable things are treated in different paragraphic location; similar facts are stated in dissimilar phraseology; and a character strongly emphasized under one species is not at all considered in another. In one paragraph a certain page of a certain book or journal is cited in one form, and in an adjoining paragraph in another form and perhaps under another author, and possibly even with a different page reference in case, as is often true, author's separates of the article quoted have been issued with individual pagination and even plate numbering.

At the Botanical Congress held in Madison in 1893, this and several other matters calling for uniformity of treatment in the interest of clearness were referred to committees, some of which reported at the next succeeding meeting of this Section or of the Botanical Club of the Association. The increase in intelligibility and simplicity of bibliographic citations noticeable of late years is an encouraging sign that botanists are quite willing to attempt to work out on uniform lines these matters which are of interest to all who have occasion to consult botanical literature, so soon as the method of procedure in each case shall have been carefully codified with reference to the practical difficulties which each writer has to confront.

Among the editorial matters to which really this question of citation pertains, although it practically falls back upon the author, should be mentioned a comparable treatment of comparable facts expressed by diagrams, curves, formulæ, and the like. The tendency of large volume in any publication is to economy of space by the employment of symbols or abbreviations, which must be learned and borne in mind by every reader before the facts which they stand for are intelligible. If these symbols could be standardized for all writers who use this means of expressing their facts, it would result in added value for their work and in a great saving of the users' time. What can be done for symbols, however, cannot always be done for what are treated as abbreviations, because of the fact that the word abbreviated is different in one language from what it is in another; and yet there is no doubt that much improvement can be effected in this direction, while a perfectly uniform result for the entire world may be ultimately attainable by falling back upon the Latin language for words which are to be abbreviated.

Detail matters of this kind are often considered too trivial to occupy the attention of a body like a section of the American Association, but I am convinced that the numerous discussions which have taken place before the Botanical Club and our own Section have resulted in a much clearer general understanding of the proper meaning of many terms that most of us use almost daily, than would otherwise have been possible, and that each of us has profited to the benefit of his readers by the information elicited by these discussions; and I cannot conceive a more useful way of spending a part of the time of this body each year than in the discussion of subjects of this kind, carefully selected and referred in advance to members or committees capable of discussing them authoritatively from different points of view.

Some of the facts of plant distribution, whether referring to the occurrence of a given genus, species or variety over the earth's surface or at different altitudes, or to the minuter details of distribution demanded for an accurate presentation of some phases of ecology, demand the use of maps, more or less detailed according to the matter to be presented. Nothing is simpler than to so shade or color these maps as to indicate what the author desires to bring out, but, unfortunately, different maps dealing with the same general facts are usually colored very differently. Map evolution consists primarily in the indication of physiographic features, on which political boundaries are more or less artificially superimposed, the representation of geological structure, and the further indication on this foundation of the biological facts which are intended to be shown. The work of the physiographer and geologist is already done to the hand of the botanist, in most cases, and when it is not he is early confronted with the need of supplying deficiencies which exist. It is not many years since the geologists turned their attention to a standardization of their maps which is already simplifying geological literature. Will it not be better for botanists, who already know fairly well the main biological facts that are capable of expression on maps, to confer with the zoologists, who have comparable though different needs of map employment, and with the geologists and topographers, on whose work both can most profitably build, so as to secure an early standardization of method, than to wait until the otherwise necessary confusion due to independent individual practice shall have forced this upon them? I cannot conceive a better outcome of the conference to be held this summer on plant geography than the appointment of a committee to consider this question in detail, not only with reference to their own needs, but to the needs of botanists at large and in consultation with those in other parts of the world who are considering the same problem and the best way of solving it.

If I have confined my remarks thus far to details of internal editing, I should not wish it supposed that other and more general matters do not exist which are worthy of equal thought. No small part of the confusion in citing publications comes from the issuance of the same matter in several different places, either at the same time or at different times, either similarly or differently paged, not infrequently with different titles, and sometimes under a title so phrased as to give no indication of the contents. Books are always likely to undergo revision between different editions and, unfortunately, this is sometimes true of different issues which do not purport to be editions, and an article once published in a journal or book which is not copyrighted becomes by common acceptance the property of the world and may be reprinted legitimately under the author's name, and properly with the further citation of the original place of publication, for an indefinite number of times, during which process it may undergo considerable modification. It is difficult to see how this can be avoided, and it is difficult to see how reprints can be cited otherwise than with reference to themselves and their original sources, but a great deal of confusion may be avoided if writers who have occasion to refer to reprints (in contrast to separates) will always indicate that they have done so.

We have fortunately in large part passed the age of secondary titles, and it is a matter for congratulation that it is now rarely necessary, when using a new book, to give a secondary or still more subordinate title as a means of specifying the particular work referred to; and the citation of older books makes the occasion for thankfulness that this is so, very evident to all who use the library. In one respect, however, a great improvement is needed. Librarians, who are a very practical set of people whose purpose now is to make any book quickly accessible to anyone who knows either its author, title or subject, have adopted somewhat arbitrary but very serviceable rules for cataloguing and cross-referring, intended to secure this end. With an isolated book comparatively little difficulty is found, but between distinct books, and articles in proceedings or other periodicals, there is an insensible intergradation, owing to the publication of series of various degrees of complexity, which are calculated either for the convenience of a certain class of readers, the glorification of the author or the emolument of the publisher, or are necessitated by the great development of institutional research and publication.

I do not wish to cite examples of terrible things to be avoided, which even a casual inspection of the contents of any large library reveals, but I should not wish to pass the subject by without calling attention to the very great need of editorial reform which devolves upon those who are charged with publishing series, and particularly those whose publication responsibility is so great as to force upon them the unquestionably necessary establishment of such differentiated series. In a late number of the monthly Public Libraries, Mr. Reinick presents a suggestive statement of a librarian's difficulties in the arrangement and cataloguing of the United States Government documents, which is worthy of perusal not only by librarians, but by persons who have occasion to cite such documents and those who are concerned with their publication. Some four years since, Mr. Frank Campbell, of the library of the British Museum, published a series of essays under the collective title 'The Theory of National and International Bibliography,' in which the question here raised is given instructive if perhaps not always final treatment. No one who has occasion either to arrange, catalogue or use the publications of the various branches of the Indian Government or of our own Government, or the publications of our several states, or of the agricultural experiment stations with which each of these states is now provided, or, finally, the contributions which are emanating from the more important research centers, chiefly in the form of separates or reprints of articles originally published in magazines or the proceedings of learned bodies, can fail to see at once the necessity for a collective treatment of all publications organically connected in their origin, and the fact that Mr. Reinick's device of stamps by which the librarian can supply necessary information not printed on the title page is necessitated if the members of a given series are to be unquestionably brought together, carries between the lines a suggestive commentary on the existing facts.

I hope that I have sufficiently brought out my own belief that the writer, the editor and the publisher, who frequently work independently of one another, are in reality tied together by a very close bond, in so far as they are aiming at the real purpose of publication, its usefulness, and that the librarian, the indexer and the reviewer are no less necessary links in the chain between the publishing investigator and his numerous and increasing readers. The practical recognition of this intimate connection is no less necessary for the promotion of the rapid advance of science which the present activity of investigators promises than the unification of the methods of the investigators themselves, and can no doubt be secured in the same manner.

In conclusion, I wish to ask attention for a few minutes to a matter of prime interest to all botanists, since it will probably affect the very prosecution of many of their studies before the next century shall have been closed. I refer to the protection and preservation in every possible way of our native and natural vegetation. To the systematist, the physiologist, and the morphologist, this is alike of importance. Agricultural lands, in the main, of necessity must have their native plants replaced by others if the latter are more valuable to man, as surely as grazing lands have been stocked with cattle after the extermination of the less useful bison. But the erection of an agricultural practice, based on a preliminary clearing of the ground, is quite different from the denudation of the land without further purpose than the utilization of its native products. Primarily the question is an economic one and as such it interests the community at large ; but it is also a question of the deepest concern to science. Climatology, the past, present and future geographical distribution of animals and plants, and ecology and evolution are so clearly connected that their devotees possess a common interest in the preservation of natural conditions at least until the factors in biologic nature shall have been directly ascertained and correlated; and I need scarcely add that what has thus far been done in this direction is little more than a rough blocking out for the future. Hence it is that local societies for the protection of animals and plants are worthy of general support in their efforts, and that the widespread forest protection movement, which is too commonly looked upon as simply an economic or sentimental matter, should receive the united encouragement and support of naturalists and meteorologists as a movement the success of which alone can perpetuate for any great time the conditions upon which much of their profounder study is to rest. This Association is to be asked to endorse an effort for the local preservation of the red-woods over a considerable area in central California, and the location of a forest reserve in the southern Appalachians. It is to be hoped that whatever action may be taken shall rest not upon hasty impulse, but upon such recognition of the vast scientific as well as utilitarian importance of this movement as shall ensure the permanence of our interest in every step of the kind which may originate in the future.

William Trelease.
Missouri Botanical Garden.

THE STRUCTURE AND SIGNIFICATION OF CERTAIN BOTANICAL TERMS.

While it is in some sense true that technical names are merely arbitrarily constructed vehicles for conveying ideas on special subjects, in the coining of such terms from the ancient languages for use in scientific description and discussion, it is desirable, at least from an educational point of view, that they should not only be appropriate, but that they should not involve any real etymological error in their construction. From a like point of view it is no less desirable that, when used antithetically, they should be strictly correlative in both construction and signification, as well as relatively constant in each of the three etymological elements which are used in the composition of such terms, namely, the prepositional, verbal and substantival. A considerable number of terms, derived from the Greek, which have come into use in anatomical and physiological botany, while they have been generally accepted and approved, are sadly wanting in some one or more of these requirements. I allude to such terms as heliotropism, geotropism, apogeotropism and diageotropism, which are used with reference to certain plant movements; and to hypocotyl, epicotyl, hyponasty and epinasty, which are used with reference to certain structural conditions.

The terms geotropism and heliotropism, as first proposed by Frank in 1868 and since used by Darwin and botanists generally, are intended to designate respectively the act of the radical portion of plants in turning downward, or toward the earth, and that of the stemmate portion in turning upward, or toward the sun; but in neither case is this accepted signification etymologically the true one. Geotropism being derived from *γῆ*, the earth, and *τρόπος*, a turn, or turning, literally signifies earth-turning; and heliotropism, being derived from *ἥλιος*, the sun, and *τρόπος*, similarly signifies sun-turning. That is, because they are each composed of verbal and substantival elements only, the prepositional element being omitted, their conventional signification is really far-fetched. Long before either Frank or Darwin used these terms in their present conventional sense, the term heliotrope was used to indicate the habit of the flowering parts of certain plants in facing and following the sun in its daily course. This act being really synheliotropism, or a turning with the sun, is quite different from that which Frank indicated by his special use of the old term. It seems to have been for this reason that Darwin happily proposed in its stead the term apogeotropism, and for the first time introduced the necessary prepositional element in the construction of this class of botanical terms. Strangely, however, although he at the same time also employed that element in the construction of his term diageotropism, he failed to add it to Frank's term geotropism, which should have been written epigeotropism* to make it strictly correlative and antithetic with apogeotropism. These two terms, when made to contain three elements each, are appropriate for the use intended because they signify and fully express the acts of turning toward and from the earth without reference to the sun as the assumed objective point of direction.

Before either Frank's or Darwin's incomparable works containing these and related terms reached America I had, as Professor of 'natural history' at the Iowa State University, constructed and personally used in my lectures the terms epitropism and apotropism in the same manner and for the same purpose that Frank's geotropism and Darwin's apogeotropism are respectively used. These terms I derived from Greek prepositional and verbal elements only, namely *ἐπί*, toward, *ἀπό*, from, and *τρόπος*, a turning omitting the substantival element *γῆ*, the earth. Because they are thus shorter and more conveniently useable in their adjective and adverbial forms they seem to be preferable to Frank's and Darwin's corresponding terms, even if the former should be amended by adding the prepositional element. While the omission of either the prepositional or verbal element from such terms as these is a real defect, the omission of the substantival element from apotropism and epitropism does not in the least obscure

* While it is true that the radical signification of the Greek preposition *ἐπί* is upon, it is often, and no less properly, used as equivalent with the English to, or towards.

their meaning because of the special character of the subject in the discussion of which they are employed.

The terms hypocotyl and epicotyl of Darwin, and hyponasty and epinasty of DeVries are objectionable because, being respectively antithetical terms, they are wanting in correlative construction. That is, in their derivation, ἐπί, upon, to, or toward, is made the antithesis of ὑπό, below, or under; whereas ὑπέρ, above, or over is the proper antithesis of ὑπό. Therefore if hypocotyl is used, its antithetic correlative should be hypercotyl; and similarly the correlative of hyponasty should be hypernasty.

Not only are the terms hypocotyl and epicotyl etymologically defective, but their use as originally proposed is not always structurally appropriate. Darwin proposed these terms to indicate the up-growing and down-growing portions respectively of the germinating plantlet, and it is evident from his use of them that he assumed the axis between the opposing portions to be practically identical in position with the points of attachment of the cotyledons. As a matter of fact, however, the cotyledons do not mark any material division in the structure of the plantlet, and the axis referred to is quite independent of their position. In many plants, the bean, for example, the axis is much below the cotyledons and the latter therefore rise above ground as the plantlet grows; while in many other plants, the pea for example, the axis is above the cotyledons, and the latter therefore remain underground. For this inconspicuous, but real, dividing disk between the up-growing and down-growing portions of the plantlet, and also of the mature plant, I have long personally used the term tropaxis, of partially Latinized Greek derivation; and for the parts above and below the axis I have used the adjective terms apotropic, and epitropic respectively.

The terms proposed by Frank, Darwin, DeVries and others have passed into the literature of botany with all their excellencies and imperfections, while my terms apotropism, epitropism and tropaxis have never been published although I have for more than thirty years accustomed myself to their use. I still think they have much merit and therefore offer them for consideration in connection with suggestions for correcting the structure and use of certain terms now generally employed.

Charles A. White.
Smithsonian Institution,
June 25, 1900.

LYMPHOSPORIDIUM TRUTTÆ, NOV. GEN., NOV. SPEC. THE CAUSE OF A RECENT BROOK TROUT EPIDEMIC.

In October, 1899, my attention was called to a disastrous epidemic among the brook trout in a Long Island hatchery. The first evidence of the epidemic was seen in May, 1899, when the director picked out a dead fish from one of the ponds and saw that one side was pierced by a clear-cut hole. Thinking the hole due to some bird like a kingfisher, he threw the fish away without further thought. When, however, he found other dead fish with similar wounds, and when the death-rate became noticeably large, an attempt was made to stop the headway of what was then recognized as a disease. Precautionary measures were useless, and during the summer the fish died off at the rate of hundreds per day. Nor did the disease stop until, in December, every fish in the ponds had died.

Investigation begun in October showed the cause of the trouble to be a hitherto undescribed genus of parasitic Protozoa, which I have named *Lymphosporidium truttæ*, belonging to the same class (Sporozoa) as the malaria germ, although the effects of the parasite on the fish are in no way similar to the effect of the malaria-organism in man. Evidences of the disease in the fish were shown by the sluggish movements and diminished vitality, while many had clear-cut holes or ulcers, as described above. Others appeared with the eyes entirely gone; in others great patches of skin and underlying muscle tissue had fallen out, leaving large irregular pits in the body walls; others still had lost fins or lower jaws, etc.

Upon working out the life-history of the parasite, it was found that spores accumulate in the lymph spaces of the fish and prevent normal nourishment of the tissues, which die and fall out leaving holes in the body-walls. The spores are taken into the digestive tract of the fish—it is not known from where they came originally; in the intestine they give rise to eight sporozoites or germs each of which develops into an adult amœboid individual not more than .001 inch in length. These adults penetrate the bundles of unstriped muscle cells of the intestine and there become mature. At maturity a spherical spore-forming cyst is formed in the lymph of the fish; here also the spores are liberated, and are then carried to all parts of the body where at different points the accumulations are formed which lead to ulcers.

Two very important points were not determined viz, (1) the origin of the disease which hitherto has probably been unknown, and, (2) the remedy. There was little chance of finding out after October how the disease originated in May, while the extinction of all the diseased fish before the parasite was even discovered effectively headed off experiments with remedial measures.

Gary N. Calkins.

EMBRYOLOGY OF LEPAS. *

This paper was based upon the results of an investigation recently completed, which was undertaken with the view of applying the cell-lineage method in an accurate study of the cleavage and the formation of the germ-layers in *Lepas* and other Cirripedes.

The cleavage of *Lepas* is total, unequal, and regular. Stages of 2, 4, 8, 16, 32, and 62 cells are normally formed. Cells of a given generation may anticipate their companions in division, but no second division of such cells takes place before all other cells have completed corresponding cleavages and become of the same generation.

The first cleavage is nearly parallel to the long axis (polar) of the ellipsoidal egg. The egg is divided into an anterior ectoblastic cell and a posterior yolk-bearing macromere. The second cleavage is at right angles to the first, both cells dividing, and from the yolk-macromere is cut off a second ectoblastic cell. The third cleavage is essentially perpendicular to the first two, dividing all the cells, and a third ectoblastic cell is separated from the yolk-macromere, which is now mesentoblastic. Thus by the first, second and third cleavages three protoplasmic cells are separated from the yolk. These three cells contain all the ectoblast and by repeated division they form and extend the blastoderm. The fourth cleavage separates the mesoblast from the entoblast, which is now represented by the yolk-macromere. The 16-cell stage is composed of fourteen ectoblastic cells, which largely surround the entoblastic yolk-cell. The single mesoblast cell lies in the blastoderm at the posterior edge of the blastopore where the entoblastic yolk-cell is still exposed to the exterior. By the fifth cleavage all these cells are divided, the two mesoblastic cells still remaining on the surface. During the sixth cleavage the two mesoblastic cells before dividing sink beneath the blastoderm as it closes over the blastopore. At the same time four cells of the blastoderm, lying at the anterior and lateral edges of the blastopore, divide perpendicularly to

* Abstract of a paper read before the Biological Section of the New York Academy of Sciences, April 9, 1900.

the surface. Four cells are thus formed beneath the blastoderm, and they are apparently added to the mesoblast, for in the next stage their derivatives can not be distinguished from the rest of the mesoblast. The entire mesoblast then originates from one cell which is separated from the entoblast in the fourth cleavage (16-cell stage), and from four other cells which are derived from the ectoblast in the sixth cleavage forming the 62-cell stage. The lineage of these four 'secondary' mesoblasts has been traced back to the first and second ectomeres.

The course of the cleavage as sketched above has been determined to be quite constant. Cells of definite origin in the early cleavage stages are the ancestors of cells which occupy particular positions in later stages. Following Conklin's terminology ('97), the cleavage may be characterized as 'determinate.' This conclusion is completely opposed to the results of the earlier investigators of Cirripede development.

Gastrulation is of the epibolic type, and is the result of the extension of the ectoblastic blastoderm over the entoblastic yolk-macromere. The blastoderm usually closes over the blastopore during the sixth cleavage (62 cells). The blastopore is identified as marking the ventral and posterior of the future embryo.

In the general features of the late development of the embryo the results of this investigation confirm those of some earlier workers.

A paper with figures in support of all the above conclusions has been prepared, and is now awaiting publication.

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ERNST HARTIG.

Ernst Hartig, 'der Geheime Regierungsrat Professor Dr. Hartig' of the 'kgl. Sächsische Technische Hochschule,' at Dresden, died April 23rd. He was born, Jan. 20, 1836, studied at the Dresden Polytechnikum, finding in the late Geheimrat Professor Dr. A Hulsse an inspiring teacher and a warm friend through whose encouragement and aid he was induced promptly to take up a line of study and work which gave him, ultimately, large opportunities and great reputation. He became, in 1862, the assistant for mechanical technology and was promoted to his professorship in 1865. In 1890 he became the director of the Technical High school. He was active in the organization of the various technical departments and the laboratories of engineering research and made himself an authority relative to the materials of engineering and in all departments of textile work. He published some important papers.

His 'Untersuchen uber die Heizkraft der Steinkohlen Sachsens' came out as early as 1860; from 1864 to 1869 he was engaged in the pursuit of a number of researches and published the results of an experimental investigation of the power required in the operation of spinning and weaving machinery. In 1873 he brought out his work of similar character on the machine-tools and in 1876 that on the machinery of the combed wool manufacture. At the desire of its author, then surrendering his hold upon his long-sustained work in that direction, Hartig undertook the preparation and admirably completed the issue of the fifth edition of Karmarsch's 'Handbuch der mechanischen Technologie' for his old friend and teacher and assumed thenceforth the position of a leading authority in that branch. From 1877 he had much to do with the formulation and systematization of the patent laws and patent systems of the kingdom and of the empire, accomplishing much for the inventor, and for the courts as well. He was an admirer of the United States system and recognized its enormous influence upon the welfare of the country and in encouraging that fecundity in invention which has always distinguished this country. His spirit, his learning and his logical mind are exhibited in 'Studien in der Praxis des k. Patentamtes,' 1890.

Hartig was named as 'kgl. sächsischen Regierungsrat,' in 1876, and as 'Geheimen Regierungsrat,' in 1888. He was decorated with the 'sächsischen Albrechtsorden Komthur 2 kl.,' and the 'sächsischen Verdienstorden Ritterkreuz I. kl.,' the 'preussische Rote Adlerorden 3 kl.' and the 'österreichische Franz Josef-Orden Ritterkreuz' and was made a member of many learned societies.

Ernst Hartig was one of the most modest and companionable of men, kindly, considerate, seeking to please his friends, and always most courteous to strangers. As a colleague on the International Jury of 1873, the writer, working side by side with him for weeks together, came to know the man and to recognize his admirable personal qualities most fully. His affection for his older colleagues and his former teachers, his friends and his pupils was always in evidence. His mind was a storehouse of information and his sincerity and quiet dignity gave him an aspect of age which was yet contra-indicated by his alert and youthful movement. He will always be remembered by those who have known him as one of the most admirable of men, the best of friends and the most able and useful of workers in a field in which there is never likely to be a surplus of such men.

R. H. Thurston.

SCIENTIFIC BOOKS.

The Grammar of Science. By Karl Pearson, M.A., F.R.S. Second edition revised and enlarged. London, Adam & Charles Black. 1900. Pp. 548.

It is possible to acquire a speaking and indeed a fairly extensive knowledge of a language without any special attention to its grammatical peculiarities. The conscious realization of syntax and conjugation, or of rules and exceptions may be quite unnecessary in 'picking up' an acquaintance with a new tongue in its local habitat. None the less the student even of 'French at a glance,' or of 'Fourteen weeks in German,' finds it profitable to include genders and declensions, and principles of structure in his aperçu. The more earnest student and, most of all, the specialist must penetrate still more deeply into the intricacies of grammatical structure and development. The same is true, though more readily overlooked in regard to the language of science. In both cases a facility of comprehension and expression, and a sympathy with the pervading spirit or genius of the language are of inestimable value, and for many purposes are indefinitely more useful than knowledge—particularly than unassimilated and uninterpreted book knowledge—of the results of analytical acumen. A scientifically-minded person may be more at home in the realm of scientific fact, may be less likely to wander astray, than he who has greater knowledge of principles with less insight into their practical combination. The observant but empirical linguist may interpret usage with greater success than the formal philologist. None the less the grammatical principles of science are of inestimable importance in imparting breadth and scope as well as depth of insight and vigor of logic to the conceptions of professional scientists and of that larger class who think scientifically and find an interest in scientific problems. That Professor Pearson's 'Grammar of Science' has met the needs of such thinkers creditably and suggestively, is evidenced by the appearance of the second edition, as well as by the comments of approval which greeted the first issue of the volume.

It will hardly be necessary in the notice of this second edition to present an account of the several chapters and of the method of treatment of the book; it will suffice to outline the scope and power of the whole. Three general groups of topics are included. The first portrays the general scope and spirit of science, or describes the purpose of the worker; the second interprets its fundamental conceptions, or describes the tools of the trade; the third outlines and comments upon the content of the sciences, or describes the materials to be worked upon. Science "claims that the whole range of phenomena, mental as well as physical—the entire universe is its field. It asserts that the scientific method is the sole gateway to the whole region of knowledge." The scientist is characterized by a logical attitude, by a manner of dealing with reality, which when carefully controlled leads to truth, to a common and verifiable possession of mankind. Science discourages short cuts to knowledge and immortality. Science admits and emphasizes its limitations; in an ultimate sense it does not explain but only describes; it has no relations with the supersensuous and is most suspicious of the metaphysical. Science justifies its place in human evolution by the efficient mental training it provides,* by the light it brings to bear on many problems of society;† by its practical benefits in extending control over natural resources and in increasing human comfort; by the permanent gratification it yields to the intellectual and æsthetical impulses.‡

Next we must recognize that all knowledge is a reaction of our mental functions to the stimuli of the environment. There is an essential intervening psychological process between knowledge and reality. We 'construct' our universe, and 'two normal perceptive faculties construct practically the same universe,' and thus render the results of thinking valid. A law of nature is "a *résumé* in mental shorthand, which replaces for us a lengthy description of the sequences among our sense-impressions. Law in the scientific sense * * * owes its existence to the creative power of his [man's] intellect." "It economizes thought by stating in conceptual shorthand that routine of our perceptions which forms for us the universe of gravitating matter." With a just comprehension of the fact that conceptual results form an essential portion of the equipment of science, which is by no means limited to perceptual sense-experience, we may proceed to develop the most profitable conceptions of those general relations underlying the problems of the special sciences. What are cause and effect, and probability? What is the scientific interpretation of space and time, of motion and matter and of their combinations in the physical and organic worlds? With these tools well sharpened and adjusted to their materials the scientific artisans may be sent to their several workshops to work with what success they can command; they devote themselves to physics and chemistry and mechanics; and they find the most distinctly different material in the realm of biology and in the several phenomena of life and evolution. And it is because the sciences are not ready-made material but represent the variety of human interest and the conceptual reactions to perceptual experience that their attempted classification has yielded so diverse and on the whole so unsatisfactory results.

Such, in brief, is the progress of thought in Professor Pearson's 'Grammar.' Many will differ with him in one and another of his positions. The metaphysician will be quick to point out that Professor Pearson's horror of metaphysics is itself the product of a metaphysical assumption; and if the more easy-going scientist expresses his belief that all these matters, like æsthetic judgments, are matters of taste, the logical reply is not far to seek. They are matters of taste, of good taste and bad taste; of sound and critical analysis or of slipshod and loose assumptions. "To know requires exertion, and it is intellectually easiest

* "It is the want of impersonal judgment, of scientific method, and of accurate insight into facts, a want largely due to a non-scientific training, which renders clear thinking so rare, and random and irresponsible judgment so common in the mass of our citizens to-day." "Scientific thought is not an accompaniment or condition of human progress, but human progress itself." (Clifford.)

† "Strange as it may seem, the laboratory experiments of a biologist may have greater weight than all the theories of the state from Plato to Hegel!" "The first demand of the state upon the individual is not for self-sacrifice, but for self-development." "The formation of a moral judgment * * * depends in the first place on knowledge and method."

‡ "If I were compelled to name the Englishmen who during our generation have had the widest imaginations and exercised them most beneficially, I think I should put the novelists and poets on one side and say Michael Faraday and Charles Darwin."

to shirk effort altogether by accepting phrases which cloak the unknown in the undefinable.'' Others again may object to the particular make-up of this 'Grammar'; may question whether the long discussion of the quantitative aspects of evolution (a novel feature of the second edition) however interesting in itself, finds a co-ordinate place with the rest of the chapters, or whether it represents unduly the special trend of the writer's interests. But no critic can fail to find the general treatment rigorous and suggestive, and to feel that the possibilities of presenting the fundamental conceptions of science to the student have been appreciably increased by Professor Pearson's labors in his behalf. JOSEPH JASTROW.

The Microscopy of Drinking Water. By GEORGE CHANDLER WHIPPLE. New York, John Wiley & Sons. 1899. Pp. xii + 300. With 21 figures and 19 half-tone plates.

The biological examination of potable water has been conducted upon an extensive scale in this country for more than a decade, especially in Massachusetts where the State Board of Health and the City of Boston have maintained laboratories for the scientific investigation of water supplies. It is fitting, therefore, that the first extensive hand-book upon the subject of the microscopy of drinking water should have been written by one long associated with this work.

Mr. Whipple's 'Microscopy of Drinking Water,' is more, however, than a mere manual, for it presents the generalization derived from the explorations and statistical data accumulated by the State Board of Health, the Boston, and more recently the Brooklyn Water Works for a series of years. It thus treats of many problems of limnology and fresh water biology of interest not only to the sanitary engineer and water expert but to the biologist and physicist as well.

The opening chapter is devoted to a historical treatment of the subject in which the faunistic and systematic biology of fresh water, and planktology also, are included. The treatment is brief and there are many omissions. There is, for example, no mention of recent investigations of water supplies in European cities, nor is any reference made to the lacustrine explorations of the United States Fish Commission in past years. The excellent work of the Bohemian Survey and of the Balaton Lake Commission in Hungary is unnoticed. Hensen, the father of planktology, is referred to as having devised a 'new method of studying the minute floating organisms found in *lakes!*' The planktonocrit is ascribed to Dolley, and the Plankton pump to Ward and Fordyce. The first use of the centrifuge in plankton work seems to have been made by Krämer or Cori, and the pump for the collection of plankton was used by Henson, by Peck, at the Illinois Biological Station, and by Frenzel, before the pump named was described.

Bacterial examination is not treated in the work as its methods are different and involve other processes than microscopical examination. The purpose and relative values of the various forms of sanitary examination are discussed at length by the author. The physical, biological and chemical analysis of water supplies are each important, and are mutually supplementary. The interpretation of an analysis is a matter of expert skill quite as much as the making of the analysis. "In the detection of pollution the chemical and bacteriological examinations furnish the most information, in the study of the æsthetic qualities of a water the physical and microscopical examinations are most important, while in investigations concerning the value of a water for industrial purposes the physical and chemical examinations sometimes suffice." The purposes of microscopical examination are stated to be the detection of sewage pollution, the explanation of turbidity, of taste and of odor of water, the interpretation of chemical analysis, and the study of food of fishes and other aquatic animals. The most important service which the microscopical examination of potable water renders is thus in the study of its æsthetic qualities.

The Sedgwick-Rafter method of water examination is described with its various modifications and improvements, and the errors incident to its use are discussed. The error from leakage through the sand may rise as high as 25 per cent. or even 50 per cent. when minute organisms are present in large numbers, and the statement is made that most of the escaping organisms pass through the sand in the earlier part of the filtration. In the reviewer's hands this method has yielded even larger errors with water heavily charged with minute flagellates and other motile organisms, when checked by more precise methods of filtration. The greatest escape of organisms occurred, not at the beginning, but toward the close of the period of filtration. The author concludes that the method is precise within 10 per cent., *i. e.*, two examinations of the same sample seldom differ by more than that amount.

A few pages are devoted to a brief discussion of the plankton method in which the Reighard and Birge nets are described though the more generally used Apstein model is not mentioned. The author objects to the standard unit of volume, a cubic meter, adopted by planktologists on the ground that it necessitates the use of large numbers in the case of minute organisms. In plankton work a uniform unit is a necessity and the small unit of the Sedgwick-Rafter method, which he suggests, is equally objectionable, as it would frequently necessitate the employment of fractions or decimals, and could not be readily correlated with most available and generally accepted unit for quantitative work, viz, the cubic meter. The statement that 'many delicate organisms are crushed upon the net' in the collection of plankton and that the pumping method conduces to imperfect filtration are not borne out by the practical experience of the reviewer.

The comparative absence of organisms in rain and ground waters and in filter-galleries is noted, and their relative abundance in surface waters is discussed. The general statement is made that standing water contains more organisms than running water. "Samples from rivers, unless collected near shore, seldom contain many organisms. Organisms found in streams are largely sedentary forms. Their food-supply is brought to them by the water continually passing. In quiet waters there are found free-swimming forms that must go in search of their food." It is undoubtedly true that there is but little plankton in the small and rapidly flowing streams of New England and in like waters elsewhere ; but in larger streams there is a true plankton, often abundant, and very largely made up of typical plankton organisms, as has been shown by investigations of the Elbe, the Oder, the Danube, the Nile, the Illinois and the Mississippi Rivers. The current probably bears some inverse ratio to the number of organisms present in a stream, but the fact of its presence does not necessarily preclude the development of an abundant and typical plankton in river waters, provided *time for breeding is afforded.*

Interesting data concerning the physics of lakes and reservoirs, especially in regard to the seasonal overturning of the water and summer stagnation below the thermocline, are to be found in the chapter on limnology. The organisms which occur in water-supplies are listed with reference to the frequency of their occurrence and their obnoxious qualities. In all 186 genera are catalogued of which but 18 are common, and of these at least 10 are troublesome because of their unpleasant effects upon potable waters. The relative frequency of different organisms and the relation of their occurrences to the depth of the pond, to the nature of the bottom, to the color of the water, and to the chemical analysis are discussed in the light of statistics accumulated in the biological examinations of Massachusetts waters. The same data afford a basis for a treatment of the seasonal, horizontal and vertical distribution of organisms in pond and reservoir waters. Technical matters such as the odors of water-supplies, the storage of ground, and of surface-waters, and the growth of organisms in water-pipes receive expert attention.

A considerable part of the work is given up to a descriptive list of the genera of microscopic organisms which will be of great assistance to the amateur or the beginner. Nineteen well-executed half-tone plates will further assist in the identification of the more common organisms. We note the omission of *Pleodorina*, which occasionally becomes a water-pest ; that *Spirodela* is figured as *Lemna;* and that *Diaptomus* appears on the plate with the ovisac *dorsal* to the abdomen.

The bibliography at the close of the book seems to be very full in the technical phases of the subject of water supplies. On the biological side it is less satisfactory, the titles by no means representing the best or the latest literature of the subject, a defect easily remedied in a later edition.

The work of Mr. Whipple is an invaluable guide for the microscopical examination of potable water, in comprehensiveness and execution far surpassing all previous manuals of the subject in the English language, or for that matter in any other. It is also of great interest to the biologist, since it summarizes from literature not ordinarily gleaned the contributions of many workers on various problems of fresh-water ecology. It is to be hoped that this book will serve as a stimulus to all engaged in this field of applied biology to contribute to the solution of the many unsolved problems which their facilities and opportunities peculiarly fit them to attack.

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Analyse Chimique Qualitative. Par M.-E. POZZI-ESCOT. Paris, Gauthier-Villars.

This little book is instructive and valuable, as the author, instead of following the beaten track of qualitative separations, adopts mainly the methods of M. Ad. Carnot, and of Engel and Silva for metalloids. He gives especial attention to the detection of the rarer elements, utilizing methods of Cleve, of Wyronboff and Verneuil, and others.

Some of the methods of Carnot are rapid and give elegant results; the method of separating cobalt, nickel, iron, zinc, manganese, thallium, indium, and uranium, utilizing hydrogen peroxide may be particularly commended.

EDWARD RENOUF.

DISCUSSION AND CORRESPONDENCE.

DEFORMED STERNA IN THE DOMESTICATED FOWL.

THE fact that the keel of the sternum is frequently crooked in the domestic fowl has long been known to me, but until the publication of several papers either discussing the cause of this deformation, or bringing it forward as an instance of the inheritance of an acquired character, the reason for it had seemed quite evident. Now it may be that this is one of the cases where a thing is not so simple as it appears to be on the surface, but the primary cause for this curvature of the sternal keel has always seemed to me enforced flightlessness and consequent failure of the pectoral muscles to pull the sternum straight, while this may be aggravated by the feeding of corn which forms flesh, but not bone. Another factor would seem to be the effort to breed fowls that shall be heavy in flesh, attempting to increase the size of the pectoral muscles at the very time the sternum is diminishing in size from the disuse of these same muscles. Thus while the sternum as a whole is degenerating a larger keel is needed for the attachment of muscles and under these conditions the only way to obtain more surface is by the curvature of the keel. It has been remarked that thoroughbred fowls are more liable than others to have deformed sternal keels and these it may be noted are the very birds that get the least amount of exercise. The games, and other breeds not raised for flesh usually have straight sterna while the heavy-bodied Asiatics are particularly liable to have crooked sterna and it may be said that the same deformation often occurs among fancy pigeons bred for show and deprived of exercise by being cooped up in lofts.

That a deformation inconstant in direction and far from universal should not be regularly inherited is not surprising; that it is due to resting the breast on the perch, although this may be one of various causes, is doubtful; that cases where the deformation seems to be passed from mother to chick should be regarded as instances of the inheritance of an acquired character is even more to be doubted.

Finally it may be said that this twisting of the sternal keel is much greater in a dried sternum than in one that is fresh or has been soaked over night in water. Among the sterna of Great Auk collected in 1887 not one was straight, although they could be made straight by soaking and it is a difficult matter to find a straight keel on the dried sternum of a Murre or Razorbill.

F. A. LUCAS.

REMARKS ON THE LOESS IN NORTH CHINA.

ALTHOUGH there has been considerable discussion regarding the loess of North China, there are some facts which have not been presented with sufficient prominence, although mentioned by Pumpelly and others. In a trip of 450 miles from Pekin into Mongolia by way of Kalgan, I observed the following facts:

(1) The loess is a wind deposit without doubt. Along the Tsing-ho, a river joining the Yang-ho near Kalgan, I found that all the north and south tributary valleys had slight deposits of loess in sheltered spots along both sides, and on the south or southeast slopes of the mountains. In the east and west valleys the north side of the valleys, that is the south slope of the mountains exhibited loess hundreds of feet steep, and clinging in sheltered spots to the very summit of the mountains more than 5000 feet above tide.

On the other side of these east and west valleys the loess deposits are practically wanting, except in gullies where there would be a lull in the wind.

The Chinese, who have overrun the Mongolian border, make use of this firm perpendicular cleaving loess for excavating houses which stand well. So the towns are usually found on the south or southeast slope of the mountains, where they have the loess to build in, or to build with, and also the sunny south exposure.

As a rule, depending on the local physical structure of the country, these deposits are rather more on the southeast than south side. In other words, the prevailing winds, then as now, blew from the northwest, down over the plains of Mongolia, the escarpment of which runs from northeast to southwest.

(2) In the valleys it often shows modification by water action. In the valleys and even half way up the mountains bands of rock fragments usually very angular are of common occurrence. These are of local origin and in all cases could be easily accounted for. They were either talus accumulations from the hill back of them, or else were deposited by some temporary stream which was formed by one of the sudden and terrific rains to which this section is subject during the summer months.

In one of the pits northwest of Kalgan there is a U-shaped deposit four feet across, of well-rounded gravel, some of the pebbles being three inches in diameter. It looks as if a stream of considerable size and superloaded with gravel from the hills near by had run over the loess at this point for a short time during the latter's period of deposition.

Lower down in the valley of the Yang-ho, 100 or 200 feet above the present river, especially where side streams have built up deltas at the point of emergence from the mountain passes into the valley, beds of sand, gravel and loess are interstratified. Probably this loess is material brought down either by the main river when it was at a higher level or by the side stream and deposited in slack water.

(3) There was some special period of rapid deposition, and that in quite recent time. Now this loess is everywhere deeply channeled by the little streams that are cutting it away. A very characteristic channel is one 20 to 30 feet, deep, 3 feet wide at the base, and from two to three times as wide at the top. Such miniature canyons will often be cut back a few hundred yards from the valley. Evidently this loess was deposited very rapidly at one time and then for some reason, probably lack of material, ceased to accumulate.

At present there is enough wind to do the work if it had the material at hand. Having been for seven hours in a dust and sand storm between Hsiian-Hua-Fu and Kalgan, I feel certain that the present wind forces are sufficient to deposit loess much more rapidly than it would erode away, provided it had the material. As it is the wind deposits now forming are entirely different from the loess. The drifts are in the same sort of places, but instead of being an impalpable dust are sand. At Hsiian-Hua-Fu the city wall is banked to the very top with drifts of sand, but no loess.

At some recent time the winds must have had an excessive amount of this peculiar fine dust at its command, and the dust must have come from the plains of Mongolia. Whether this material was supplied by glacial grist, furnished by glaciers coming down on to the Mongolian plains from the elevated mountain region to the northeast, or not, remains to be seen. One thing is certain. The glaciers never extended down to the edge of the Mongolian plateau in this region (Lat. 40° North).

(4) This deposit is very recent, for many of the smaller streams have not yet cut their way through it to the rock. This is in marked

contrast to the broad deep valleys in which the loess was deposited—valleys 3000 feet deep and 2 to 7 miles wide.

FRED. B. WRIGHT.

TIENTSIN, NORTH CHINA, May 30, 1900.

POWER OF THE EYE.

TO THE EDITOR OF SCIENCE: We often hear people say that they can merely by a steady gaze affect a person at a distance who is not looking at them; and some say that they are able to make one sitting in front turn the head in this way. Mr. Bell in his 'Tangweera' (p. 198) mentions this feeling when he says: "Presently I felt as if someone was looking at me, and, raising my head, saw a large puma standing ten yards off." To the physiologist it may seem uncalled for to investigate a manifest absurdity, but it has at least a practical value to explode a common error by direct experiment. I asked a young man, who is very confident of his powers, to stand, unknown to re-agent A, behind a book case, and look through a carefully concealed peep hole. I gave him the best opportunity, placing A about four feet from the hole and directly facing him, and I engaged A in mechanical writing. To the young man's confessed disgust and irritation he was unable to disturb A. My few experiments were negative in results. However, it may be that telepathic influence is exerted under certain conditions, and experiments with twins and others constantly *en rapport*, especially when under emotional stress and at critical junctures, might be worth trying. If there be nervous telepathy, this is, perhaps, as simple and common a form as any. If disturbance arose subconsciously the test would be that the tracings from an instrument to show nervous conditions should show large fluctuations coincidently with the times when the agent regards himself as successful.

HIRAM M. STANLEY.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIÈRES OR FREEZING CAVERNS.

A HANDSOME volume under the above title by E. S. Balch has just appeared (Allen, Lane and Scott, Phila., 1900, 337 pages, many illustrations). Nearly a third of the book is given to a narrative of personal experiences in visiting 'ice caves' or freezing caverns in various parts of the world. Fifty pages follow on the causes of subterranean ice; the first suggested and simplest explanation, the cold of winter, being held sufficient against a variety of legendary and fanciful processes. The prevalent belief that freezing caves are colder in summer than in winter and that ice forms in the warm season is controverted by direct observation. The reason for this curious perversion of fact is probably to be found in the temperature contrasts between cavern and external air in summer and winter; the cavern air feeling colder than the open air in summer and warmer in winter. Thermometric records show, however, that cavern temperature is relatively constant all the year round. The whole story is that cold air enters from the outside in winter time and produces ice when there is water to freeze. This simple explanation is confirmed by the occurrence of glacières only in regions where the winter has temperatures below freezing. A compendious list of glacières occupies 100 pages; abstracts of many opinions concerning them, 40 more; and a good bibliography and index close the volume. The views of the ice stalagmites in the glacière de Chaux-les-Passavant in the French Jura are excellent, and the book as a whole is highly creditable to American geographical scholarship.

THE OLD MOUNTAINS OF MICHIGAN.

MONOGRAPH XXXVI, U. S. Geological Survey, by several authors, treating of the Crystal Falls iron bearing district of the upper peninsula of Michigan, contains an instructive account of physiographic features amid a great body of geologic and economic details. The items here abstracted are from chapters by Smyth and Clements. Although the district is partly underlaid by resistant and deformed pre-Cambrian rocks of diverse structures, and partly by weak and gently inclined upper Cambrian sandstones, the most general aspect of its surface is that of a somewhat rolling plain with a gentle and uniform descent for about thirty miles from an altitude of 1800–1900 feet in the northwest to 1200-1300 in the southeast. The areas of harder rocks form broad swells of moderate relief, but there are no commanding eminences; the widest panoramas from the hill tops extend but a few miles, and the general evenness of the skyline is usually broken only by remnants of the old forest, not yet cut or burnt. It is significant that the name 'mountain' has been applied by local surveyors to hillocks only 100 or 200 feet in local relief. The minor features are explained by the scouring action of the ice sheet on this preglacial peneplain. The areas of massive crystalline rocks have a surface mammillated with rocky knobs and pitted with hollows; the first are largely bare, the second are filled to their brim with ponds or quaking bogs. Ledges and scarps are found at the border of the stronger rocks, while the weaker rocks, eroded to a somewhat lower level, are covered with drift plains which are mostly followed by the main streams. The drainage is very immature, varying irregularly from standing water in lakes and sluggish meandering streams in swamps to flowing reaches in graded drift channels and rushing rapids on rocky ledges. The lakes have generally been reduced to a lower level than that of their original shore line; they are often surrounded by muskegs or reduced to 'hay marshes.' Swamps cover a large part of the surface, not only filling many basins and valley floors, but ascending gentle slopes to the spring line on the hillsides; their thick spongy carpet of moss retains sufficient moisture for the growth of cedars and other swamp-loving trees and shrubs.

This district is of interest as a sample of the geographic conditions that prevail over a vast area of the Laurentian highland in northeastern Canada; an ancient mountainous region, reduced to moderate relief before the Cambrian strata were laid upon it, and since then remaining remarkably quiescent while so many changes were going on in other parts of the world.

WATERPOWER IN NORTH CAROLINA.

Bulletin No. 8 of the North Carolina Geological Survey (Raleigh, 1899) is devoted to an account of the water powers of that State, contributed by several writers. The volume opens with a chapter on the general physiographic features of North Carolina, in which the essential peculiarities of coastal plain, piedmont plateau and mountain belt are well presented by J. A. Holmes. The fourth chapter, by the same author, discusses the geologic distribution of waterpower and refers the rapids and falls of the rivers to their controlling causes. In the mountains, falls are determined by irregular variations in the resistance of the crystalline rocks; here short ungraded rapids frequently alternate with longer graded reaches. The narrows and falls of the Yadkin in the piedmont plateau occur where the river crosses a belt of resistant schist between belts of weaker argillaceous slates. The Roanoke descends 85 feet in nine miles as it passes from the piedmont crystallines to the weak strata of the coastal plain. The Tar has an abrupt fall of 15 feet at Rocky Mount, some 20 miles east of the border of the piedmont area, where the river has cut down through the coastal plain strata upon a reef of schists and resistant granite. The greater number of pages is devoted to details of individual rivers. The volume is well illustrated by half-tone plates.

W. M. Davis.

BOTANICAL NOTES.

RECENT BOOKS FOR SECONDARY SCHOOLS.

Professor Barnes has prepared a little book under the title of 'Outlines of Plant Life,' for use in such secondary schools as cannot give as much time to the subject as is required by his earlier 'Plant Life.' He has omitted much of the minute anatomy 'upon the assumption that no laboratory work with the compound microscope is possible,' an unfortunate assumption in our opinion. However, the author does not reduce his work to this low plane, but freely introduces suggestions for microscopical studies quite at variance with his prefatory statement. The sequence of structural study is from the simple to the complex plants, considerably more than a hundred pages being given to this part of the subject. This is followed by about the same number of pages devoted to physiological studies, and sixty pages of ecological matter. It should be very helpful to teachers.

The same publishers (Holt & Co.) bring out a smaller edition of Professor Atkinson's 'Elementary Botany.' The author assumes that the compound microscope is available, and proceeds to plan the work accordingly. The sequence here is in our opinion not as philosophical as that in Dr. Barnes's book, beginning with physiology (114 pp.), with structural studies next (164 pp.), followed by ecology (59 pp.). However, the teacher will find much which is helpful in the book, which has the merit of having much original matter in it.

Here perhaps may be noticed Professor W. W. Bailey's booklet 'Botanizing,' intended to be a guide to field collecting and herbarium work. For this it is apparently well fitted. It describes the equipment necessary for the work in the field as well as in the herbarium, and tells just how the work should be done for different groups of plants. It is not a modern book, for the department of botany with which it deals is not modern. When another edition appears it may be well to make it a field manual in a sense broad enough to include ecological work.

A STUDY OF NON-INDIGENOUS PLANTS.

Professor and Mrs. Kellerman, of Ohio, have been studying the non-indigenous flora of that State, publishing their results in the *Journal of the Cincinnati Society of Natural History* for March, 1900. They find that there are known 2060 flowering plants in the present flora of the State, of which 430, or a little more than 21 per cent., are non-indigenous. Of these foreigners 326 came from Europe, 30 from Asia, 2 from Africa, 46 from Southern and Western United States, 21 from tropical or South America, while 5 are of unknown nativity. It will be seen that more than 83 per cent. of these plants came from the Old World. Fifty-five natural families are represented by one or more species, the largest being Compositae (88), Gramineae (46), Druciferae (27), Labiatae (24), Caryophyllaceae (23), Leguminosae (19), Rosaceae (15), Polyponaceae (14), Scrophulariaceae (14), Umbelliferae (12), Boraginaceae (11), Chenopodiaceae (11). While many of these introduced plants are useful, many also are weeds, no less than 49 falling within this category, and of these all but eight come from the Old World. In order to show that by no means all of the weeds are exotic, the authors give a list of 40 troublesome weeds which are natives of Ohio.

NEW SPECIES OF INSECT PARASITES.

Dr. Roland Thaxter, who is the authority on the group of insect parasites constituting the family Laboulbeniaceae has been able to add very materially to our knowledge of the group by a study of the material derived from an examination of the entomological collections in Paris, London, Oxford, Florence and Washington. He discovered 168 new species, belonging to 22 genera, some of the latter also being new. The genus Laboulbenia is enriched by the addition of 100 species. The new genera are *Monoicomyces*, with four species: *Polyascomyces*, with one species; *Limnaiomyces*, with two species; *Eucorethromyces*, with one species; *Misgomyces*, with two species, and *Euzodiomyces*, with one species. The descriptions of these new genera and species fill two numbers (9 and 21) of the *Proceedings* of the American Academy of Arts and Sciences, Vol. XXXV., issued respectively December, 1899, and April, 1900. Dr. Thaxter makes the welcome announcement that it is his intention to publish as soon as practicable a supplement to his 'Monograph of the Laboulbeniaceae' with figures of all the species.

PHYSIOLOGY OF TOBACCO.

An interesting paper entitled 'Physiological Studies of Connecticut Leaf Tobacco,' by Dr. Oscar Loew, contains much of importance to the general plant physiologist, as well as to the practical grower of tobacco, as may be seen from the author's 'conclusions' which we quote in full. "Various problems relating to the manufacture of tobacco have been touched upon in this report, some of them within easy reach of solution, others of a very difficult nature. The prevention of fungous attacks in the barn or in the cases, the regulation of the temperature and humidity in the curing process, and the proper control of the sweat are points that can easily be settled. In many cases the replacement of the stalk-curing by the single-leaf curing process may prove a financial success. But there are other problems of a more delicate and difficult nature, as the prevention of the mosaic or calico disease and the proper composition of the tobacco leaf while ripening. Upon this composition depends the development of a desirable aroma in the sweating process. Climate and weather are here such potent factors that human art can accomplish directly but little. Too cool and rainy weather may favor, for example, the production of fatty matter, which certainly exerts an unfavorable effect upon the aroma in smoking. There may be produced, however, still other products which are unfavorable to the aroma. Too dry weather may also interfere with the proper composition of the ripening tobacco leaves. By crossing and selection, however, varieties of tobacco may possibly be produced that even under favorable climatic conditions will not form much of the compounds which injure the aroma. In regard to the selection of the seed, it may be mentioned that even now some farmers go so far as to import their seed directly from Cuba each year."

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The University of Nebraska.

THE RECENT SOLAR ECLIPSE.

A joint meeting of the Royal Society and the Royal Astronomical Society was held on June 27th to hear preliminary reports from several expeditions that went out to observe the recent eclipse of the sun. Lord Lister, the president of the Royal Society, was in the chair, and with him was Professor G. H. Darwin, president of the Royal Astronomical Society. According to the report in the London *Times*, Mr. Christie, the astronomer royal, first presented an account of the observations made by himself and Mr. Dyson at Ovar, in Portugal. There totality lasted 84½ seconds, and though the sky was rather hazy he secured some good photographs. The plates employed were 15 inches square, and, owing to their size, were rather awkward to handle; hence he was only able to expose five during totality. The exposures ranged from one and one-half to fifteen seconds. The resulting pictures were exhibited. In several of them the prominences and inner structure of the corona were well shown, while in others considerable extensions of the corona were visible. Mr. Christie also showed some of the pictures taken by Mr. Dyson with a double camera; in one of these at least greater coronal extensions could be traced than were visible to the eye. As to the corona, it seemed very distinctly inferior in brightness, structure and rays to the one seen in the Indian eclipse, appearing, indeed, quite a different object.

Sir Norman Lockyer next described the observations made by the Solar Physics Observatory Expedition and the officers and men of H. M. S. Theseus at Santa Pola. This place, which lay very near the central line of the eclipse, was selected because it appeared likely to meet the requirements of a man-of war, and without the assistance of a man-of-war the manipulation of long focus prismatic cameras in a strange country was impracticable. Two of these instruments were used, one of which was a new one with a Taylor triple lense of 6-in. aperture and 20-ft. focal length. Out of the great wealth of photographs at his command Sir Norman Lockyer only exhibited a few to give a general idea of his results. Four coronographs were employed. The corona appeared to him a repetition of the one seen in 1878 and different from that of 1871; in several respects he obtained confirmation of the differences between the coronas at periods of sunspot *maxima* and *minima*.

Professor Turner spoke of the observations he had made with Mr. H. F. Newall in the grounds of the observatory near Algiers. He himself had undertaken the photographic work, while the spectroscopic fell to his colleague, a joint program of polarization work being also carried out. Professor Turner spoke strongly in favor of the coelostat, which he had employed, as an instrument for eclipse work, and showed several of the photographs he had obtained. From observations on the brightness of the corona he concluded it was many times brighter than the moon—perhaps ten times as bright.

Professor Ralph Copeland described the observations he made on behalf of the joint committee at Santa Pola, endorsing Sir N. Lockyer's remarks as to the advantage of having the aid of a man-of-war. With his small prismatic camera, in which the optical parts were of quartz or Iceland spar, he was in India, working the instrument himself, only able to take four photographs, and in one of these at least the instrument was shifted. But an able seaman was able this year to get six perfect exposures with it. Professor Copeland also used the big telescope, 40 feet long, which he had employed on other occasions.

Mr. J. Evershed presented a preliminary report on his expedition to the south limit of totality. His reason for choosing a site at the limit of totality was that the flash spectrum was there visible very much longer. Unfortunately, he accepted the guidance of the Nautical Almanac Office, and found himself outside the line of totality—about 200 metres according to his informants, who said a small speck of sunlight was visible all the time. He was successful in obtaining some fine photographs of the flash spectrum.

THE THIRD INTERNATIONAL CONFERENCE ON A CATALOGUE OF SCIENTIFIC LITERATURE.

PROFESSOR HENRY E. ARMSTRONG contributes an article to the current number of *Nature* from which we take the following facts regarding the recent Conference on a catalogue of scientific literature :

In view of the proceedings of the Conference there can be little doubt that the ultimate execution of this important enterprise is now assured.

Every one was of opinion that if a fair beginning can once be made, the importance of the work is so great, it will be of such use to scientific workers at large, that it will rapidly grow in favor and soon secure that wide support which is not yet given to it simply because its character and value are but imperfectly understood. Therefore, all were anxious that a beginning should be made.

It has been estimated that if 300 sets or the equivalent are sold, the expenses of publication will be fully met. As the purchase of more than half this number was guaranteed by France, Germany, Italy, Norway, Switzerland and the United Kingdom, the Conference came to the conclusion that the number likely to be taken by other countries would be such that the subscriptions necessary to cover the cost of the catalogue would be obtained.

The resolution arrived at after this opinion had been formed, "That the catalogue include both an author's and a subject index, according to the schemes of the Provisional International Committee," must, in fact, be read as a resolution to establish the catalogue.

A Provisional International Committee has been appointed which will take the steps now necessary to secure the adhesion and co-operation of countries not yet pledged to support the scheme.

Originally, it was proposed to issue a card as well as a book catalogue, but on account of the great additional expense this would involve, it is resolved to publish the catalogue, for the present, only in the form of annual volumes.

From the outset great stress has been laid on the preparation of subject indexes which go behind the titles of papers and give fairly full information as to the nature of their contents. Both at the first and the second International Conference this view met with the fullest approval. Meanwhile the action of the German government has made it necessary to modify somewhat the original plan. In Germany, a regional bureau will be established, supported by a government subvention, and it is intended that the whole of the German scientific literature shall be catalogued in this office. In such an office it will for the present be impossible to go behind titles; consequently, only the titles of German papers will be quoted in the catalogue. In England the attempt will be made to deal fully with the literature, and the co-operation of authors and editors will be specially invited. A full code of instructions for the use of the regional bureaux is now being prepared under the auspices of the Provisional International Committee.

The catalogue is to be published annually in seventeen distinct volumes. The collection of material is to commence from January 1, 1901. As it will be impossible to print and issue so many volumes at once, it is proposed to publish them in sets of four or five at quarterly intervals. During the first year, parts covering shorter periods will be prepared, so as to make the subsequent regular issue possible of volumes in which the literature published during a previous period of twelve months is catalogued. Unfortunately the United States and Russia were not represented at the Conference.

SCIENTIFIC NOTES AND NEWS.

Professor Henry F. Osborn, professor of zoology, at Columbia University, and curator of vertebrate paleontology of the American Museum of Natural History, has been appointed paleontologist in the United States Geological Survey. Professor Osborn's special field of work will be to take charge of the vertebrate paleontology of the Survey, especially with reference to the completion of the monographs for which the illustrations were prepared under the direction of the late Professor O. C. Marsh.

It is reported by cablegram from London that Professor E. C. Pickering of Harvard University has been in conference with Sir David Gill with a view to a survey of the east coast of Africa, in which it is said American men of science will participate.

The Society for the Promotion of Engineering Education, on July 5th, elected the following officers for the ensuing year: *President*, Professor C. O. Marvin of the Kansas State University; *Vice-President*, Professor Albert Kingsbury of the Worcester Polytechnic Institute; *Secretary*, Professor H. S. Jacoby of Cornell University; *Treasurer*, Professor C. A. Waldo of Purdue University.

Dr. Thomas H. Norton, lately professor of chemistry in the University of Cincinnati, who was recently appointed by the President to establish a United States Consulate at Harpoot, Turkey, in Asia, has sailed on the steamship *Archimede*, of the Italian line, for Constantinople.

Dr. W. C. Stubbs, director of the Louisiana Experiment Station, has been selected by the Secretary of Agriculture to visit the Hawaiian Islands and report upon the most feasible plan for the establishment of an agricultural experiment station there. Dr. Stubbs will spend the month of August in the Islands investigating the locations best adapted to a station, the lines of work which should be undertaken, and matters relating to the necessary equipment and expense of maintenance.

Dr. S. A. Knapp, of Louisiana has gone to Porto Rico on a similar mission. These preliminary investigations are in accordance with the recent acts of Congress making appropriation for the office of Experiment Stations of the Department of Agriculture, providing for the establishment of agricultural experiment stations in these island possessions.

Dr. J. Walter Fewkes of the Bureau of American Ethnology has returned to Washington after eight months absence in the field devoted to a further study of the Hopi Indians in Arizona.

Dr. Cleveland Abbe, Jr., of Winthrop College, is spending the field season in Western North Carolina and Virginia as special assistant to one of the hydrographic parties of the U. S. Geological Survey. He is engaged in special study of the physiography of this district while also assisting in the hydrographic survey that is being made by the co-operation of the N. C. State Geological Survey and the U. S. Geological Survey.

Professor Josiah Royce, of Harvard University, has been invited to give a course of lectures at Dublin University.

Professor George Lincoln Goodale, of Harvard University, will be absent on leave next year, and Dr. Rodney H. True has been appointed lecturer in botany for the year.

A conversazione was held at the London Medical Graduates' College and Polyclinic on July 4th, when the museum was inaugurated, and Professor Osler, of Baltimore, gave an oration on 'The Teaching of Practical Medicine.'

At a dinner given on June 24th, in honor of the yellow fever expedition of the Liverpool School of Tropical Medicine, Mr. A. L. Jones subscribed £1000 towards the erection of a hospital for tropical diseases in Liverpool. In addition to smaller gifts, two subscriptions of £500 from Mr. Blaize, of Lagos, and Mr. John Holt, of Liverpool, were announced.

The annual visitation of the Royal Observatory at Greenwich, which was this year, owing to the solar eclipse, postponed for a month, took place on June 26th. Among those present were Sir David Gill, from the Cape of Good Hope, Sir William Huggins, Sir George Stokes and Professor George Darwin. The Astronomer Royal exhibited photographs of the corona taken at Ovar, Portugal, compared with those taken in India, under similar conditions, in 1898. Other work reported upon was the observations and photographs taken with the 28-inch refractor and the Thompson equatorial, including observations of Capella, with a view to determining whether it could be observed as a double star.

IT appears from a recent report of the British Museum that the visitors to the natural history collections at South Kensington rose from 419,004 in 1898 to 422,290 in 1899. In 1899 the weekday visitors numbered 366,572 and the Sunday visitors 55,718, as compared with 368,572 and 50,432 in the previous year. The visits paid to the particular departments for the purpose of study fell from 20,177 in 1898 to 19,120 in 1899. The trustees have agreed to co-operate with the Egyptian Government in a survey of the Nile to determine the species of fishes inhabiting the river. A scientific expedition is to be dispatched to Lake Tanganyika. Particulars are given of the expedition to Sokotra undertaken by Mr. Ogilvie-Grant and Dr. H. O. Forbes, and of Dr. J. W. Gregory's exploration of West Indian Islands.

THE Boston Appalachian Mountain Club held its 35th field meeting from June 30th to July 7th. Professor C. H. Hitchcock, of Dartmouth College, was one of the guides and was the principal speaker at the evening meeting.

THE large flying cage of the New York Zoological Park, built at a cost of $8000, has been completed and numerous birds have been placed in it. It is the largest cage ever constructed, being 150 feet long, 75 feet wide and 55 feet high.

AN institute for the study of oceanography is to be established at Berlin. Among questions proposed for special study is the mixing of the waters of the Baltic and the North Sea in the canal connecting them. The Baltic, owing to the numerous rivers flowing into it, is less salt than ocean water and its fauna becomes modified as it passes along the canal.

THE daily papers report that Baron E. von Toll will head a Russian expedition which is to search the Arctic coast of Europe and Asia for traces of Andrée. It will start from Norway, proceed by way of Nova Zembla, pass the ensuing winter at Cape Chelyuskin, Taimyr Peninsula, and, searching the Siberian coast during the summer of 1901, endeavor to reach Bering Strait. This dangerous passage has not been attempted since its accomplishment by Baron Nordenskjöld in 1871–3. Capt. W. Bode will this summer take a party of Germans to Franz Josef Land and communicate with the Italian expedition under the Duke of Abruzzi. A Swedish and a Russian expedition will operate in Spitzbergen. Three expeditions, one Swedish, under Professor Vatthoff; a Danish one under Professor Amdrup, and an English one, under Capt. Robertson have already started for the east coast of Greenland.

THE University of Pennsylvania has issued a directory of its graduates in engineering which will be sent on application. The graduates number 469, of whom 445 are living. Of these, about seventy-one per cent. are engaged in engineering practice, twelve per cent. lines in related to engineering, thirteen per cent. in other professions and pursuits, and the addresses of the remaining four per cent. are unknown.

THE *British Medical Journal* reports that the German Government proposes to establish special plague laboratories at Freiberg and Heidelberg for the diagnosis of any suspicious cases of the plague that may occur, and for the prosecution of researches as to the cause of the disease.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Captain George S. Towle, U. S. A., Wellesley College receives practically the whole of his estate which is said to amount to about $100,000. The income establishes a fund to assist worthy students.

BY the will of the late Mrs. Rebecca Reyburn of Baltimore, $20,000 is bequeathed to the Catholic University of America.

BEREA COLLEGE has secured subscriptions for $150,000 which makes available Dr. Pearson's gift of $50,000.

A JESUIT priest of Mindanao has presented to the Roman Catholic College, at Georgetown, a collection of corals said to be of much value. The collection also contains shells, opals, etc.

The University of Michigan has established two new courses, namely Higher Commercial Education and Public Administration, which will be open to students this fall. The aim of these courses will be to train men and women for the larger commercial, industrial, political and social opportunities which are now offering themselves to the younger generation. These courses are semi-professional in character and, within the limits of sound scholarship, may be arranged with especial reference to the careers that individual students have in view. Instruction will begin with the opening of the University, September 25, 1900. In connection with these courses six non-resident lecturers have been added to the faculty of the University of Michigan. They are: E. D. Jones, Ph.D., assistant professor in the University of Wisconsin, lecturer on Industrial Resources of the United States; O. M. W. Sprague, Ph.D., instructor in Harvard University, lecturer on International Division of Labor; Lyman E. Cooley, C.E., Chicago, lecturer on the Industrial Significance of Deep Waterways; Robert T. Hill, B.S., United States Geological Survey, Washington, D. C., lecturer on the Industrial Significance of the West Indies to the United States; Thomas L. Greene, manager Audit Company of New York, New York City, lecturer on the Function of the Financier in Industrial Organizations, and W. F. Willoughby, Ph.D., Department of Labor, Washington, D. C., lecturer on the Function of Trades-Unions in Industrial Organizations.

At the commencement exercises of Alma College in Michigan the new Francis Hood Museum of Natural History was dedicated, and it was announced that the geological collection of the late Alexander Winchell had been presented to the college. In connection with the dedication of the museum, Professor Jacob Reighard, of the University of Michigan, gave an address entitled 'Biology and Education.' Dr. A. C. Lane, the State geologist, said, in connection with the presentation of the Winchell collection, that it was one that a university would be glad to possess and that it must be visited by all students of the paleontology of Michigan.

The new physical laboratory at Owens College, Manchester, was opened on June 29th by Lord Rayleigh. The new laboratory will have a larger floor area than that of any other similar institution in the world, with the exception of the Johns Hopkins and the Strasburg laboratories. The equipment includes the most modern apparatus for use in every branch of science. Research laboratories are an important feature of the new buildings. The electro-technical wing constitutes a John Hopkinson memorial, and on the occasion of the opening ceremonies was formally handed over by the relatives of the late Dr. John Hopkinson. Professor A. Shuster, the director of the new laboratory, will be assisted by Dr. C. H. Lees, and Mr. R. Beatie has been appointed lecturer in electro-technics.

The Board of Governors of McGill University has made the following appointments in the faculties of applied science and medicine. Neville N. Evans to be assistant professor of chemistry, Dr. James Henderson to be senior demonstrator in chemistry, Fred. Soddy, B.A., Douglas McIntosh, B.Sc., Ph.D., and Charles F. Lindsay, B.Sc., to be demonstrators in chemistry; Dr. N. D. Gunne to be lecturer in histology, S. B. Allan to be demonstrator in civil engineering, E. Andrews to be demonstrator in mining, P. W. K. Robertson to be Dawson fellow in metallurgy.

At Baldwin University, Berea, Ohio, E. W. Berger has been re-elected to the chair of natural science.

Oliver J. Lodge, F.R.S., professor of experimental physics, at University College, Liverpool, has been appointed principal of the newly established university at Birmingham. Professor Lodge, born in 1851, who has held the chair at Liverpool since 1880, is well known for his researches on electric waves and other physical subjects and as a brilliant writer on theoretical physics.

In the same university Dr. W. D'Este Emery has been appointed lecturer on bacteriology.

Mr. L. Lewton-Brain, of St. John's College, and Mr. A. W. Hill, of King's College, Cambridge, have been appointed university demonstrators in botany.

SCIENCE

FRIDAY, JULY 20, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*PRE-CAMBRIAN SEDIMENTS IN THE ADIRONDACKS.**

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Stratigraphical geology had its rise in those old mining regions of Germany, the

* Address of the Vice-President and Chairman of Section E of the American Association for the Advancement of Science, given at the New York meeting, June, 1900.

The field work on which the above paper is based was done under both the U. S. Geological Survey and the New York State Geological Survey. All the data under the authority of the latter and here drawn upon have been printed. For permission to use much unpublished matter belonging to the former acknowledgments are here respectfully made to the Hon. Charles D. Walcott, Director.

Hartz, the Erzgebirge and Thuringia; and speaking as I do, in a lecture room of our oldest American School of Mines, it is a special pleasure to note this connection and to render to the ancient art of mining—the real mother of geological science—her just due. There is no doubt in my mind that the keen observation of miners had convinced them that there was some regular succession in the rocks, long before this principle found accurate, scientific expression in printed form; but, so far as we know, it was first formally stated by Johannes Gottlob Lehmann in connection with some profiles or cross-sections of the Hartz and the Erzgebirge, which he prepared about the middle of the last century. Lehmann, who was a mining official under the Prussian government, had observed that flat and undisturbed beds rested upon earlier tilted beds and upon crystalline rocks, both of which latter he assumed as his original base but with whose relations he did not concern himself. A few years later in Thuringia, George Christian Fuchsel dealt in a tectonic way with the Coal Measures, the Permian and the later systems, but as we all know it was not until the close of the eighteenth century that William Smith made known the use of type fossils in English geology, nor was it until 1808 that Cuvier and Brogniart, working upon the extremely regular deposits of the Paris basin, established for France if not for the world the use of fossils on a large scale. They brought out a definite system, which anticipated by a few years the issue of William Smith's famous map of England.

It was natural that these results should be attained in regions of simple and easily deciphered stratigraphy, and of relatively modern beds. Taught and inspired by this pioneer work, the geologists of the quarter century that followed interpreted the Tertiary and Mesozoic strata, wherever fairly flat and undisturbed. Even the Coal Measures were studied and placed in their true position, but except in New York, where the older series are likewise flat and undisturbed, the lower lying Paleozoic remained a sealed book. It even seemed a rash and foolhardy undertaking when the two English geologists, Sedgwick and Murchison attacked the hills and mountains of Wales and Devonshire some 75 years ago. The structural problems which this region presented were esteemed too complex and too difficult to justify the expenditure of effort upon them. Sedgwick and Murchison, however, found the clues and by careful work finally classified the strata and despite faults, folds and moderate metamorphism, placed them in their true position. These observations opened up for investigation the whole Paleozoic and set the pace as well as laid out the course for stratigraphical geologists until a decade or two since. So much has now been accomplished, however, that even in regions of very violent change, the problems of the Paleozoic may now be considered to be in a high degree solved, and the range of work upon its series and stages has become chiefly faunal and biological.

But the course of geological investigation has tended ever downward to lower and lower horizons. It may be said that in recent years the chief problems of stratigraphic interest have involved that tempting yet elusive series of sediments that lies below the limits of well-preserved and recognizable fossils. The remains and organisms, which are so abundant and useful in the Paleozoic, disappear in the most remarkable way as we go below the Cambrian, and yet there are few geologists who do not confidently believe that in some corner of the world, not yet fully explored, they will be found in satisfactory abundance. Traces are of course already known. Walcott, in the West; Matthew, in the maritime provinces; and Barrois, in Britany, have met with encouragement, but the great discoveries remain for the future, because as yet the evidence is meagre and amounts to little more than a stimulus for later work.

And yet despite the lack of organisms, the elucidation of the genetic and structural problems supplied by these ancient sediments is of the highest interest and importance. They carry us ever farther and farther back toward the primeval conditions on our planet, and year by year the circle of the recognized Algonkian closes in on the admissible Archean, and year by year the ancient gneissic areas yield up the secrets of their pedigrees.

Not all the sedimentary rocks, once regarded as pre-Cambrian, have proved to be such on investigation. In many localities metamorphic schists, once supposed to be very ancient, have been safely lodged in the Paleozoic fold, but many more remain and there will be no lack of material for the next generation of geologists to work upon. In all the advances, methods of observation and interpretation have been developed, and the results gained in one locality have been of the greatest service in another. In the Highlands of Scotland, under the guidance of Peach and Horne, we have learned the part that overthrust faults may play and have realized the complex, although not quite hopeless, aggregate of tangled strata which may result. In the Lake Superior region, Irving and Van Hise and their co-laborers have developed the methods applicable in a region, folded in a complicated way and more or less metamorphosed, although not faulted. In the Green Mountains, Pumpelly, Dale and others have dealt with folds, metamorphism and faults, all three. In New Jersey, Nason and Wolff have attacked the old gneisses, worse subjects for stratigraphical elucidation than any yet cited, except the Scotch, and Wolff has appealed with much if not conclusive success to inconspicuous, although fairly persistent bands of peculiar rocks to indicate traces of a sedimentary succession. Adams, in the crystalline areas of Quebec and Ontario has dealt with problems more like those which we are to pass in review to-day than are any of the localities mentioned above. They involve the most ancient gneisses, the crystalline limestones, the vast intrusions of plutonic eruptives, and the same dynamic metamorphism ; but there is one important factor in the Canadian area which we probably lack in the Adirondacks, and that is the most ancient gneiss, there called the Ottawa. At least we doubt if its equivalent occurs anywhere south of the international boundary. With the crystalline limestones and their associates in the Grenville and with the Norian intrusives, however, we have much in common.

Outline of the Adirondacks.—The Adirondacks—under which term I include the crystalline rocks of northern New York—cover about 12,500 square miles. In outline the area is somewhat like a circle, that has been flattened on the East along Lake Champlain, and pulled out to a cusp on the West toward the Thousand Islands. The diameter is very nearly 125 miles. The surface consists almost entirely of crystalline rocks, for, although a few outliers of Upper Cambrian and Ordovician beds are known as much as 40 miles from their parent masses, they are an insignificant fraction of the whole. In the area of the crystallines, metamorphosed representatives of both sedimentary and igneous originals are present. All except the small trap dikes have suffered severely from dynamic processes, sometimes to an extraordinary degree, and in instances the sediments are to be hardly if at all recognized as such. Sufficiently numerous examples, however, remain which can with certainty be referred to their originals, and great probability for the same derivation can be established for others. While deeply buried, the sediments have been invaded by an enormous mass of plutonic eruptives, of whose nature and succession we now have much evidence. So extensively has this been true on the East, that the sediments are broken up into small and often isolated areas, whose relations are difficult to decipher. On the west as shown by C. H. Smyth, Jr., they are more extensive although everywhere pierced by eruptives. After the intrusions dynamic metamorphism of a pronounced type crushed, sheared and mixed them up with the igneous intrusions; upheaval and faulting disguised the relations; and erosion removed or obscured the evidence, so that a problem is afforded, that is much the same as if the Basement Complex of the Marquette region had invaded the Huronian sediments and had split them up into small areas after which faulting had ensued. And yet in the eastern Adirondacks it does not appear that close folding has very largely if at all taken place. On the contrary, despite the dynamic metamorphism, the decipherable dips in the ancient sediments and the contacts between limestones and neighboring gneisses are often flat, and low folds if any seem to be the rule. Nevertheless crushing and granulation are very wide-spread and have often produced mashing in the rocks of all sorts, except the latest trap dikes. The mashing cannot be due to the larger intrusions, because they exhibit it as much as the sediments, and it must have followed their entrance. It preceded the Potsdam and it must have taken place under a considerable load, else there would have been more severe folding. From this brief general statement it will be seen that the problems possess their own individual characters and in a measure seem to differ from those of other regions unless it be Quebec and Ontario.

Recent Geological Work.—I pass over all mention of earlier workers in the region, because their contributions have already been reviewed elsewhere by me, and because they were not serious in a stratigraphical way. Detailed fieldwork has been required and this has only been attempted by C. H. Smyth, Jr., H. P. Cushing, myself and our assistants. Smyth has worked in the western counties; St. Lawrence, Jeffersou, Herkimer and western Hamilton. Cushing has studied Clinton and Franklin Counties on the north; and I have been busied with Essex, Warren, Washington, eastern Hamilton, Saratoga and Fulton. We have however kept in close sympathetic touch in all our work. In Cushing's area less of the undoubted sediments occur, as only two small exposures of limestone have thus far been discovered. In Smyth's area the limestones are most extensive and furnish the best large exhibitions, whereas in the region covered by myself, they are most numerous, although of smaller individual extent, but they have associated with them certain other forms of metamorphosed sediments, which are not yet recorded in such large amounts elsewhere, which are of special interest; and which throw light on the nature of the series. Smyth has suggested the name Oswegatchie series for the limestones and their associates on the West, and while the equivalency of the rocks with the previously named Grenville series of Canada seems probable in a general way, we all have agreed to use this term. Any term must however be considered more or less provisional because as will later appear there is a great gap in outcrops between the original exposures of the Oswegatchie, along the river of the same name, and the near neighbors to it, on the one hand, and the next exposures to the southeast on the other.

VARIETIES OF SEDIMENTARY ROCKS.

Before discussing the general distribution of the exposures, it will be well to give a brief resumé of the kinds of rocks with which we have especially to deal. Right in this particular appears the great difficulty of a metamorphic problem. In sedimentary or unaltered igneous rocks we are never at a loss to understand their nature and method of origin, but in excessively metamorphosed varieties the great difficulties arise in describing these questions at the very outset, and if we were only sure of many of these puzzling gneisses, the battle would be more than half won.

The Limestones.—The most easily recognized is a coarsely crystallized, white limestone and it is at the same time the widest in occurrence and the most significant evidence of the presence of the old sediments. While at times of considerable purity, as at the marble quarries at Gouverneur, it is generally more or less richly impregnated with graphite, apatite, quartz, pyroxene, horneblende, phlogopite, biotite, scapolite, chondrodite, garnet and feldspars. The silicates tend to be aggregated into streaks and bunches, that owe their shape in large part to the shearing and stretching effects of dynamic metamorphism. In the larger bunches, less common minerals, such as titanite, pyrrhotite and tourmaline are met. Most of the minerals cited above are without doubt produced by the regional metamorphism of more or less siliceous limestones. Such are quartz, pyroxene, hornblende, biotite, graphite, apatite and feldspar. But others, such as tourmaline, chondrodite, scapolite, titanite and to some degree apatite are the results of contact metamorphism, as Smyth has so well shown for the west side of the area.

A variation which is met in several localities, appears when the marbles become charged with serpentinous alteration products, from pyroxenic originals? This is true, most prominently, in Moriah township, Essex county; and in Thurman township, Warren county, although the same rock is met in less amount in a number of other places.

Regarding the development of these limestones it may be only said here, that they are beyond question calcareous and magnesian sediments which involved siliceous, ferruginous and aluminous admixtures, in some cases very richly. During metamorphism the latter elements supplied the materials necessary for the production of various silicates. The limestones appear to be less pure and consequently more charged with silicates on the east than on the west, and to present smaller cross-sections, but from this statement we must omit the contact zones of St. Lawrence county. In judging of the impurity of the limestones we must also make exception of the included masses of rocks, composed of silicates, which in the dynamic metamorphism, have been torn off from the wall rocks or from pegmatite or more basic dikes that had penetrated the limestones before the disturbances. I also reserve graphite for special consideration further on. The limestones exhibit many interesting proofs of having yielded to pressure like viscous substance. They have flowed around the harder inclusions and bordering rocks, have moulded themselves into their irregularities, and have behaved in all respects like a plastic material. This property on their part has made the determination of accurate dips and strikes a matter of difficulty and has added to the obscurity of the problem.

The Quartzites.—But little has yet been stated in print regarding the rocks of this type and they are indeed far less abundant than the limestones. In former papers reference has been made to thin sulphur-yellow beds which accompany the limestones near Port Henry. They are friable quartzites and contain much sillimanite, graphite and pyrite. At Hague, a town on

Lake George, and at a point five miles west from the lake shore, the interesting graphite mines have been opened, which show undoubted fragmental sediments. A bed some 6 to 15 feet thick has been faulted once so as to be exposed in two places. It dips to the west at an angle of 10 degrees and contains abundant flakes of graphite, all of which show a rubbed and streaked appearance from much mashing and shearing. The rock contains little else than quartz and graphite and cannot reasonably be interpreted otherwise than as sandstone, which has been richly charged with some carbonaceous matter, either originally organic or subsequently introduced as some hydrocarbon. Walcott has significantly remarked that the openings look exactly like a coal mine in pre-Cambrian strata. Beneath and above the graphitic quartzite is a garnetiferous gneiss, richly charged with sillimanite. Above the upper sillimanite gneiss is still more quartzite and all rest on a granite gneiss. I interpret the succession as one which involved a sandstone, porous enough to admit the carbonaceous matter now represented by the graphite, and interstratified in a somewhat calcareous, sandy shale now changed to the garnetiferous, sillimanite gneiss. Whether the lower granitic gneiss is an intrusive, which has developed these minerals by contact metamorphism or not ; or whether it was the old foundation on which the sediments were laid down is an obscure question, which I am unable at present to positively decide. The minerals involved are produced both by regional and contact metamorphism. At one point near the mines some small amount of limestone has been revealed by an exploring drill hole, at a shallow depth (30 feet) and on the whole I have been more inclined from the evidence in hand to consider the granitic gneiss as the foundation on which the sediments were deposited.

The largest exposure of quartzite yet recorded is in the town of Lewis, about three miles north of Elizabethtown, in Essex county. Ledges occur more or less charged with graphite and so metamorphosed as to resemble vein quartz, but stratigraphically they have a good dip and strike and they run under gneisses of which I shall later speak. The dip of the quartzite is about 10 degrees and the thickness across the stratification is about 100 feet. The general relations leave little doubt that we are dealing with an old sandstone, somewhat bituminous, and now thoroughly recrystallized. All around are great intrusions of gabbros, anorthosites and syenitic eruptives so that the quartzite remains practically as a little island in the midst of an eruptive area.

In a considerable number of other places these quartzites have been noted and as a rule they have shown a pronounced banded, if not bedded, structure and have almost always exhibited graphite. They likewise very commonly contain dark, rounded discs of a mineral that proves when examined in thin section, to be monoclinic pyroxene. It is irregular in outline and pale green in color. The rocks are therefore aggregates of quartz in excess and pyroxene in considerable amount and are to be interpreted as old quartz sandstones, that contained some calcareous and magnesian admixture, which, during metamorphism, yielded the pyroxene. A little iron oxide also entered into the result. In several instances we have found small masses of the quartzites in the anorthosites, forming inclusions which have been torn off during the intrusion of the igneous rock, and which have been surrounded by small zones or reaction rims, due to contact metamorphism.

Minor Associates of the Limestones.—Another peculiar and characteristic rock that is associated with the limestones in many places in minor amounts consists of quartz and milk-white plagioclase, with occasional titanites scattered through the aggregate. It seems to be a metamorphic product from the transition sediments between the limestones and the associated clastics.

Likewise associated with the limestones in several localities, but more especially at Port Henry and Fort Ann, there are hornblende schists, of dark black color. They are often involved with the former in a most intricate way, running in as tongues and stringers, penetrating as dikes, which may be broken up into several scattered masses, or appearing as single boulder-like inclusions. In all cases where the rocks are prominently developed, there is easily recognized, intrusive gabbro in the vicinity and the burden of probability would seem to favor an igneous origin for them. At the same time calcareous, magnesian shales might be responsible for similar mineral aggregates, when exposed to excessive metamorphism, as Professor Emerson has shown for the Chester region of central Massachusetts, and in localities of compression and mashing they might become involved in a complex way with softer beds such as limestones; but still I think the Adirondack evidence favors irruptive contacts for them and the mashing and involution of dikes.

An almost invariable associate of the limestones, but in comparatively small amount is a rock consisting of a granular aggregate of dark green pyroxene. Some little calcite may often be detected in the interstices between the pyroxene, but as a rule the coarsely crystalline bits of the former make up practically the entire mass. The rock has manifestly resulted from the metamorphism of siliceous transition deposits from the limestones to the clastics.

Garnet Pyroxene Rock.—At two localities, one in Keene valley, on the west bank of the Ausable river and about a mile above Keene Center, and the other in northwestern Lewis, extensive ledges of a peculiar rock have been met that seems to belong to the limestone series. It is quite massive and gives no trace of dip or strike. It is a coarsely crystalline aggregate of deep red garnet, and green monoclinic pyroxene. In each case the ledges are associated with hornblendic gneisses and they may be a peculiarly altered, calcareous sediment, but the mineralogy strongly suggests contact metamorphism upon limestones, although in neither case was it possible to establish the presence of eruptives in the immediate vicinity. In the Keene locality anorthosites are in masses of mountain size, within half a mile, but gneisses intervene. In the latter case no eruptives of the gabbro family are near enough to be reasonably considered causes in the effect.

The Sedimentary Gneisses.—In intimate relations with the limestones in many localities and in quite extended outcrops, without them in other places, are gneissoid rocks that are quite certainly altered sediments. They are characterized by a very pronounced and persistent banding and the banding is regular and runs for very considerable distances. The transitions from dark bands, consisting of prevailing bisilicates to lighter ones containing quartz and feldspar are abrupt and can only be accounted for by changes in sedimentation. They differ entirely from the short lenticles which are produced by the stretching of the minerals of an eruptive rock. The layers are at times quite pure quartz and again suggest the mineralogy of pegmatites. Graphite is a very common mineral and is one of much significance.

On account of fragmentary exposures and the ever present drift or forest growth it is difficult to determine the actual thickness of these rocks. In southwestern Jay township, Essex county, I have paced carefully over a series of continuous exposures of very regular and flat dipping beds that were at least 75 feet thick and then became concealed under drift. A mile away they again appeared on a mountain side with very nearly the same strike and dip and there is no doubt that a very considerable thickness is present. Gabbros in one direction and anorthosites in another cut them out, and on the strike they were traced into exposures which contained limestones. Graphite was abundant both in limestones and gneisses.

In many other localities these same rocks have been met but mostly as isolated exposures in the midst of the heavy forest growth and too few in number to enable us to work out their thickness or their accurate relationships, but there is no doubt that they represent sediments that must have been originally of the nature of sandy shales, which at times had more richly calcareous layers and which, in this way, yielded the variable metamorphic results, now accessible to us. As a rule the dips of these gneisses are low, although high dips are met.

Besides the gneisses just described, which exhibit the marked regularity in their banding there are others that are more massive and uniform, and yet that from their general relations and associations give strong evidence of belonging in the sedimentary series with the limestones. They are almost always rusty on their outcrops as distinguished from the certain eruptives and whenever this character is observed we commonly look with success for the near presence of limestones. Although apparently quite basic the microscope reveals in most cases quartz and microperthite as the light-colored minerals in the midst of the prevailing hornblende and less augite. Plagioclase is not lacking, but is decidedly subordinate. Graphite has been occasionally detected in them.

These rocks have proved exceedingly puzzling members to deal with in the field, because one would be inclined at first sight and from microscopic examination to regard them as gneissoid gabbros or diorites, but the microscope gives the results just specified and the structural relations which will be shortly taken up lead to the conclusion that they are altered sediments, and that they probably represent large and fairly uniform bodies of shale.

Professor Cushing has noted in the eastern part of Franklin county considerable outcrops of a very coarsely crystalline and slightly rusty rock, which I have likewise had the privilege of studying in the field with him. It consists of almost nothing else than lenticles of quartz, half an inch or more wide, an eighth or more thick, and an inch or two long, which are set in a matrix of microperthite. Practically no dark silicates appear. I have also occasionally observed the same rock further south and I do not know how to account for it otherwise than as a recrystallized and squeezed conglomerate, whose pebbles have been stretched and rolled out to the lenticles and whose interstitial filling has yielded the microperthite. If this view be correct, we have all the ordinary members of a sedimentary series represented among these metamorphic rocks and a much more probable association for an important and extended member of the geological column, than would any one or two of the above cited members be alone. It is quite possible that others of the more massive gneisses are altered sediments rather than sheared eruptives, but in the absence of positive proofs I hesitate to take even a tentative position regarding them, although I am free to admit that beginning with prepossessions in favor of the igneous origin of many of the gneisses, I have become more and more convinced that altered sediments play a very prominent rôle.

GENERAL DISTRIBUTION OF THE METAMORPHOSED SEDIMENTS.

The Northwest. — The crystalline limestones furnish the most widely distributed, indubitable form of pre-Cambrian sediment with which we can deal in a general sketch, but as already indicated it is fully within the bounds of probability that other kinds of rocks will be recognized to possess this same character, as time goes on and observations accumulate. The limestones are in much the largest amount of all the Adirondack localities in the northwest, where they have been investigated by Professor C. H. Smyth, Jr. St. Lawrence county chiefly contains them and they are also found in important areas in the neighboring counties of Jefferson and Lewis. They are not all accurately mapped as yet. They constitute large northeast and southwest belts as well as minor exposures, but to what extent additional ones are buried beneath the Potsdam, the Drift and the forest growth we have no means of knowing. Smyth has already mentioned four principal belts. The northwestern one is called the Macomb. It extends from Theresa township, in Jefferson county, across the county line and through Rossie, Macomb and De Kalb into De Peyster, St. Lawrence county. This makes a distance of about 25 miles and the belt may be 2 miles across. The next one to the southeast is the Gouverneur belt, the largest of all. It begins in Antwerp, Jefferson county, and runs for 35 miles through Rossie, Gouverneur, and De Kalb, terminating in Canton. It varies from 2 to 6 miles across but is somewhat divided as regards outcrops by overlying Potsdam and by gneiss. The next belt to the southeast runs from Fowler township through Edwards and terminates in Russell; and the last of the four extends from Wilna, Jefferson county, through Diana in the same county, to and into Pitcairn, St. Lawrence county. All lovers of minerals will recognize at once in these names classic localities of many species, which more than any other one product have served to make this region known, the world over.

There are other small areas in Pierrepont, Parishville and Potsdam further north, which have been located by Professor Cushing upon his published map of the boundary of the Potsdam, executed for Professor James Hall, and if we may draw inferences from Professor Ebenezer Emmons' few notes in the early Survey of the Second District of New York, still other outcrops exist toward the Thousand Islands of which Professor Smyth will no doubt prepare descriptions in time. But when one passes to the southeast of the Diana belt, Smyth has stated that for 30 miles the gneisses extend without a break. Limestones are however known at the Fourth lake of the Fulton Chain, as recorded by Vanuxem and they have been found by Smyth in small amount amid gneisses near Bisby lake and on the South Branch of the Moose river at its junction with Limekiln brook. Emmons also mentions limestones as abundant around a lake that he calls Lake Janet and again Lake Genet, and describes as being at the head of the Marion river. Lake Janet is apparently the one now called Blue Mountain lake but although fairly detailed work has been done around it by my assistant D. H. Newland, no record of these rocks was made and there may be some mistake about the earlier note.

Despite these small areas last mentioned there still remains a vast extent of crystallines that form a broad area from northeast to southwest wherein no sediments are known. This is the greatest stretch of the whole Adirondack region that is devoid of them and as it forms a somewhat pronounced belt, parallel to the general structural trend of the country, it cannot well be without some special significance. Much of this stretch in Franklin County has been shown by Cushing to be anorthosite, but to the southwest it appears to be granitic gneiss, of greater uniformity than is usual elsewhere.

The Eastern Side.—Beginning on the northeast, but one exposure has been met in Clinton County and that is a stratum about 20 feet thick and 150 feet long at the foot of Catamount mountain. Dip and strike are very difficult to determine with accuracy. The bed apparently passes into the mountain at an angle of about 45–60 degrees. The relations will, however, be more fully commented on in taking up the stratigraphical features under a subsequent topic.

Just across the line in Franklin county, and near the village of Franklin Falls, there are two separated ledges of limestone. The dips are low and with the calcareous beds are rusty hornblendic gneisses and some graphitic quartzite, the latter being certainly sedimentary and the former probably the same. Intrusions of anorthosite have served to obscure the larger relations.

In Essex county, to the south, in St. Armand township, a double bed of white, crystalline limestone outcrops at the foot of the steep, westerly spur of Whiteface mountain. It lies embedded in feldspathic gneisses, but anorthosites outcrop further up the slope. In North Elba, the next township eastward, and on the western slopes of Sentinel mountain, in the Wilmington pass, a small ledge of limestone has been met, obscurely exposed in the bed of a little brook. Passing to Keene township, the next one east, there are a number of exposures in the northern portion that together constitute a pronounced belt. From a point a mile south of Keene Center for several miles to the north, until one passes into Jay, they may be located first on the west side of the valley and then on the east. Quartzites in small amount and a great thickness of dark, rusty hornblendic gneisses accompany them. Away from the central valley and well up into the bounding ranges of mountains, limestones have been discovered both in the eastern and southeastern portions of Jay. Over the high divide in Chesterfield township, the next one to Jay on the east, two exposures have been met, each time involved with gneisses, but each time in a region where huge intrusions of anorthosite are likewise serious factors in the geology, although at some distance from the limestone. In Lewis township, next south, as well as in Elizabethtown which lies beyond, a long succession of limestones and quartzites in a general north and south belt, are met over a stretch of at least 15 miles, but they are much broken up by anorthosites and basic gabbros. In two or three instances, however, the ledges are of the greatest stratigraphical interest, as I shall shortly bring out.

In the valley of Lake Champlain a small exposure of limestone with much associated graphite forms the extreme point at the picturesque Split Rock, Essex township, a landmark to all travelers by steamer on the lake. While the amount of limestone is not great, the associated gneisses are in considerable development, before they are replaced by anorthosites, which make up the main part of the Split Rock range. No more limestones are then met until a point is reached in the hills in the extreme southwestern part of Westport, where again a small ledge has been located in the midst of an area consisting chiefly of the plutonic intrusives. In Moriah township, both on the lake near Port Henry and back in the upland valley which rises to the westward from the lake, the limestones are frequent and of considerable thickness. Next the lake they are the best exposed and thickest of any outcrops in the eastern part of the mountains. Details of the exposure have already been printed by me. In Crown Point and Ticonderoga, the next townships south along the lake, small ledges have been located in many places and relatively large areas of the associated gneisses, and if we pass right down into Washington county, on the south, we shall find in the high narrow ridge that lies between Lake Champlain and Lake George several small beds in Putnam and Dresden townships. In Whitehall and Fort Ann, however, the exposures become more serious and give greater promise of stratigraphical results. At Whitehall an attempt has been made by me to work them out, and in a report, that will shortly appear from the office of the State Geologist in Albany, a detailed map with cross-sections will be given which indicate a marked anticlinal character for them and the associated gneisses. Quartzose gneisses are also present that afford strong evidence of being metamorphosed sediments.

If now we return to the latitude of Crown point and Ticonderoga and pass westward into Schroon, we find a belt along a somewhat marked depression, ranging from western Crown Point, through the valley of Paradox lake to and along Schroon lake. There are likewise scattered outliers in the adjoining hills. Still further westward in Minerva and again to the north in Newcomb, right in the heart of the mountains and west of the highest peaks, very extended outcrops occur, as usual with the associated gneisses. They scarcely cross the line from Essex into Hamilton county to the west, but they run south through Warren county and appear in small and scattered areas in Johnsburgh, Chester, and Thurman. In eastern Hamilton county, two or three have been discovered in Wells and Lake Pleasant townships. But then they seem to end so far as our present information goes, and from these townships southward along the western border line of Hamilton county and in a sweep around to the westward along the southern rim of the crystallines, so far as known they fail. To the eastward in Warren county, we have located a number of small and scattered outcrops, amid the gneisses of Horicon and Bolton townships, while in Hague are the interesting quartzites already referred to. In the several townships that intervene on the south before the mantle of the Paleozoic conceals the crystallines, the limestone is lacking so far as known.

Resumé.—In a brief general survey of these various details, it is evident that the limestones are chiefly found along the northwest and southeast or eastern portion of the great crystalline area. In its northern portion they practically fail, and in the broad band running from northeast to southwest across it, they are unknown. They are likewise absent in the southern and southwestern border. On the northwest they are in extended and comparatively broad belts, but in the eastern portion they appear in many small and separated exposures, associated with some quartzites and much greater amounts of characteristic gneisses, but greatly broken up by igneous intrusions.

Broadly considered, it is inconceivable that we should have these numerous, thin exposures of limestones, undoubted sediments, over so wide an area, without corresponding and very much greater amounts of clastics. The comparatively few recognizable quartzites serve to corroborate the inference so far as they go, but it is still an inevitable conclusion that we must have the representatives of very much greater deposits, that have been shales or some similar materials, and that are represented now by the gneisses, because schists or slates are practically unknown.

It is also significant that so far as our present information goes the recognizable, fragmental sediments are most numerous on the east, where at the same time the limestones are thinnest and most scattered. While it is well appreciated by me, that much fuller knowledge awaits us as Professor Smyth's work progresses, yet the significance of this relation cannot be entirely overlooked, and it seems justifiable to believe that if the limestones on both sides of the mountains belong to the same geological series, the sedimentation involved more shales and sandstones on the east and more limestone on the west. To a certain degree the same relations hold good for the Trenton series to-day, its limestone being more massive on the southwest of the crystallines and more shaly on the eastern boundary. Nevertheless, for the pre-Cambrian formations, the assured, fragmental sediments are still, as emphasized above, comparatively thin and scarce, and the inferences just stated regarding the gneisses will arise. With a view of throwing light on this question a few typical sections will now be given in some detail, and in the mind of the observer or reader, the point of view should always be maintained as to whether it is possible to explain such relations by igneous contacts, or whether we must not logically refer them to a regular sedimentary succession.

TYPICAL STRATIGRAPHICAL CROSS-SECTIONS.

Catamount Mountain.—This is the most northerly of the eastern outcrops. Although the crystallines extend for miles beyond, there are no more limestones. At the foot of a steep mountain-side that looks away to the southeast and that rises from twelve to fifteen hundred feet above the valley, a ledge of limestone has been well-exposed by quarry operations. It is 20 feet thick and 150 feet long. It is a difficult matter to convince oneself of the dip and strike, but certainly the upper edge of the limestone runs along quite regularly and considered as a whole the rock seems to be a distinctly bedded mass in other rocks. The banding of the included minerals give a dip of from 45 to 60 degrees into the mountain. All exposures of rock are concealed both above and below the limestone so that its immediate associates cannot be made out, but out in the valley, in the road, a short distance to the south Cushing has noted an outcrop of a rusty friable gneiss consisting of nearly colorless monoclinic pyroxene and microperthite. With these are sillimanite, titanite, magnetite, pyrite and graphite. A band of basic hornblende plagioclase gneiss is also associated. These latter details I quote from Cushing with whom, however, I have been over the ground. In Wilmington mountain to the southeast, I have found further outcrops of graphitic rocks and of hornblendic gneisses and pyroxenic aggregates, such as are commonly associated with the limestone.

In passing up Catamount mountain above the ledge of limestone, no outcrops can be found for a distance which involves some hundreds of feet of cross-section, and then a dark gneiss appears with parallel strike and vertical dip. Under the microscope it exhibits plagioclase, green augite, less brown hornblende, garnet and magnetite, an assemblage that has strong affinities with gabbros. Near the top of the mountain this rock yields to a gneiss with abundant quartz. I forbear to attempt to interpret this poorly exposed succession at the present, merely citing it as an illustration of the relations met and of the difficulties of the problem.

The Western Spur of Whiteface.—From the northern end of Lake Placid a wild and narrow pass runs across a small divide, separating the Ausable drainage from that of the Saranac. At very nearly the crest of the water-shed and in the foot of the steep westerly spur of Whiteface mountain, a double bed of limestone has been discovered. The upper bench is 6 feet and the lower 12 with an interval of 25 feet occupied by gneisses. Up the steep slope with a somewhat flattening dip, hornblendic gneisses extend for 300 feet of section, then feldspathic gneisses for 300 feet more, until the peculiar type of anorthosite of the Whiteface massif appears. To the westward in scattered exposures hornblendic gneisses occur, until in the second row of hills anorthosites replace them. The exposures of limestone can only be traced a short distance on the strike, say 200 yards before they are concealed, but they have all the appearance of a regularly stratified, sedimentary rock, and their contacts give no evidence of igneous metamorphism. They dip into the mountain at about 40 degrees.

The Lewis Section of Quartzite.—About one mile west of Lewis post-office a ledge of graphitic quartzite arises out of the sandy terrace and, with a dip of 25 degrees to the west, extends for quite 100 yards without a break. It then dips under a series of graphitic gneisses, which may be found a little to the south across a narrow gulch. Still further westward and after an interval that is concealed, the anorthosites appear in a hillside. To the eastward of the quartzite ledge everything is concealed by a half mile of sand and then anorthosites again appear. The quartzites and their associated, graphitic gneisses present every character of a sedimentary series and while examining them one cannot resist the conviction that one is face to face with a fragment of an ancient series of clastics. Further south the anorthosites have been found outcropping within less than 50 feet of the sedimentary rocks and with abundant evidence of contact metamorphism.

The Two Exposures in Limekiln Mountain.—In the southwestern corner of Lewis and near its line with Elizabethtown, there arises a bunch of peaks, called Limekiln Mountain on the maps of the U. S. Geological Survey. The main summit is about 3000 feet above sea level. A number of valleys and gulches separate the mountain into several knobs. A gradual, drift-covered slope rises from the valley on the east to a height of about 1400 feet above tide, and then the shoulder of the mountain ascends quite abruptly. Just in the foot of this slope a ledge of limestone 20 to 30 feet thick has been opened up for quicklime. The dip is very flat, being almost horizontal. The exposures extend perhaps 50 yards and then are concealed by soil. The rock beneath the limestone is not shown, but excellent opportunities are afforded to run the section up the hill for a considerable distance. For 50 feet across the dip gneisses appear which are shown by the microscope to contain quartz, microperthite, some plagioclase, augite, and magnetite. After a concealed interval, rocks of a gabbroic character are met, consisting of labradorite, green augite, garnet and magnetite, but with no microperthite or quartz. If now we pass across the high ridge to the westward and down into the next valley evidences of limestones not well displayed may be discovered and then a quarter of a mile further and somewhat southwest from the first locality a beautifully exposed and regularly bedded stratum, 20 feet in thickness and dipping not more than ten degrees into the mountain is revealed in old workings for quicklime. Its general strike and dip are closely parallel with the one just mentioned, on the other side of the mountain but it has this advantage, that the gneisses are well shown beneath it, and one can climb the steep ledges of gneiss above it for more than a thousand feet of cross-section. They are the same quartzose, microperthitic gneisses mentioned a moment ago. The limestone itself forms a very flat and gentle roll and then disappears under the talus in each direction. Other small rolls can be traced out in the direction of the dip, before they disappear for good. In the bottoms of brooks in this same portion of the mountain, graphitic gneisses have been met, fairly remote from the limestone, but the forest growth is so thick and the exposures so fragmentary that connected structural details cannot well be worked out.

These two separated ledges of limestone

with their flat dips and close resemblance to the familiar sections in the Paleozoic or other well-defined sediments, have borne home to the writer with greater force than have any others observed in the eastern mountains the general conception of what the ancient sediments must once have been, before metamorphism, igneous intrusions and upheavals threw them out of their simple and regular relations. They show that despite the severity of the changes elsewhere displayed, two remnants remain, not appreciably mashed, and scarcely even tilted, and one can well picture to oneself a regular and widespread sedimentary series covering extended areas in this region.

The Styles Brook Section in Southern Jay.—One more section will suffice. It is located five miles from the last and beyond a group of mountains. It runs in a northeast and southwest line across a beautiful valley, about two miles wide. In the bottom of the valley, and fortunately cleared of a heavy mantle of overlying drift by a recent freshet, about 50 feet of graphitic quarzites and gneisses with a northerly dip of 35 degrees are exposed. To the northeast, within an eighth of a mile, a huge flow of basic gabbro cuts out the sediments. To the southwest, after three-quarters of a mile of drift, there are rusty hornblendic gneisses, which dip almost the same as the previously mentioned ledge of quartzite; then after another three-quarters of a mile of drift and forest-covered mountain-side, quartzite, charged with pyrite, constitutes the country rock. Anorthosites appear not far away along the mountain, but still, despite the fragmentary exposures, one must believe in the presence of a very considerable and not greatly disturbed series of sediments. Along the strike of the first mentioned quartzite in the valley abundant limestones are found within a mile.

Instances similar to the ones which have been cited could be greatly multiplied, for we have now recorded over fifty separate exposures of the limestones in the eastern mountains, but the range of phenomena is fairly well illustrated by the above. In most cases they are isolated fragments, too much broken up by eruptives to admit of working out extended structure, but as one passes into Warren county the larger manifestations of the undoubted eruptives decrease and encouraging opportunities are afforded to trace out folds or other structural features. In one or two cases this has been done by me, and the coming summer the matter will be carried further under the auspices of the State Geologist, but more detailed work is required than we have been able to attempt in the first reconnoissance.

For the greater areas of limestone on the northwest, Smyth has found evidence of a series of compressed folds, which pitch to the northeast, and which are overturned so as to dip on both flanks to the northwest, but his statements are as yet somewhat guarded.*

The Significance of Graphite.—Graphite has been tentatively referred to in many places as one of the criteria for determining the presence of sedimentary rocks, and for a moment its value in this respect deserves consideration. While I am well aware that it often appears in pegmatitic dikes or veins, and indeed that the old historic mines at Chilson Hill, Ticonderoga are based upon deposits of this character, yet it is true that the graphite is almost never met except in close connection with the limestones or their characteristic associates, or in areas where these form a prominent feature in the local geology. The commonest occurrence is immediately in the limestones and hardly an exposure of them or of the bunches of silicates in them has been discovered without the presence of the shining black scales.

* Report of the State Geologist of New York for 1893, I., 497.

When graphite appears in metamorphic rocks it has been generally considered in America and until recently abroad as well, to have been derived from organic matter originally in the sediments, but in more recent years investigations have been carried out which throw some doubt on these conceptions. Graphite, considered purely as a mineral has come in for a large share of attention and some writers have even distinguished three varieties, viz, graphite, graphitite and graphitoid, depending on differences of physical structure or behavior with oxidizing reagents. Weinscheuk, of Munich, has however quite conclusively shown in a recent paper, that all are varieties of graphite proper, differing only in fineness of scales or perfection of crystalline form. All true graphite when warmed with fuming nitric acid and potassium chlorate changes into yellow, transparent crystals, possessing the same hexagonal form as the original and exhibiting while wet and fresh, the optical properties of a negative uniaxial crystal. These are called graphitic acid. They yield by analysis somewhat variable results but they are known to have assumed over 40 per cent. of oxygen and about 1.5 of hydrogen. Other dark amorphous forms of carbon dissolve in fuming nitric acid and potassium chlorate to a brown liquid.

So far as my observations go, all the occurrences on the east are true graphite. I have not noted any other form of carbonaceous matter, but in the marbles quarried at Gouverneur there are cloudy veinings, which may not be the mineral.

In a valuable paper on the graphite deposits along the border of Bavaria and Bohemia, usually referred to as the Passau district, Weinschenk* has shown that the graphite occurs in a much decomposed gneiss, in lenticular enrichments, the best of which are associated with crystalline limestone, and all of which follow the contact line of a huge granite intrusion and at small distances from it. When the contact is left the graphite deposits become leaner and leaner and finally die out. The graphite fills all manner of cracks in the minerals of the containing rock and the interstices between the minerals and may even amount to 60 or 70 per cent. of the mass. Weinschenk concludes that the graphite has not come from original deposits in the gneiss and limestone, but from gases emitted at moderate temperatures from the granite and which penetrated into all the small cavities of the gneiss and limestone. The most probable constituents of the gases are thought to be carbonic oxide, carbonates of iron and manganese, cyanides of titanium, carbonic acid and water. All contributions from the gneiss and limestone and all other forms of carbonaceous matter are specifically ruled out.

Into the abundant other literature of graphite, especially as concerns Ceylon or other productive regions, I do not go as the important point before us is to determine the significance of the graphite in the Adirondack rocks, and to decide whether its carbon has been introduced by the eruptives. Of eruptives there is no lack, if not always in immediate association with the graphitic rocks, at least within short distances.

In any conclusions the following conditions must be met:

1. The graphite is in all the crystalline limestones, sometimes richly.

2. It is most coarsely crystalline in the pegmatitic bunches of silicates, which of all sizes from that of the finest to that of many cubic yards, are so richly present in the limestones.

3. It is richly developed in the quartzite at Hague and appears in many others in less amount.

* Weinschenk, E., 1897. Vorkomnisse aus Graphitlagerstätten nordöstlich von Passau. *Zeit. f. Kryst. and Min.*, 1897, XXVII., 135.

4. It forms scattered scales in the rusty gneisses which are associated with the limestones, but here only in comparatively small amount.

5. It enters richly some pegmatite veins and forms pockets of considerable size as well as leaf-like individuals which wrap around the component minerals of the rock, penetrate their cracks and impregnate every fissure. In the Ticonderoga veins, which cut across the foliation of a gneiss, the graphite is associated with feldspar, quartz, pyroxene, calcite and apatite, all in very coarsely crystalline development.

6. It also forms veins by itself in gneisses, as at Split Rock, near Essex, where fissures an inch or more wide are lined with large leaflets, growing out from the walls and mingled with quartz in small amount. To what depth the veins extend cannot be stated, but they run for some yards on the surface in the little prospect where they are exposed.

7. Graphite has been discovered by me in one place in anorthosite, where the latter was in close association with rocks of the limestone series. One or two small scales were detected in the midst of the labradorite crystals. Dr. Hillebrand of the United States Geological Survey has also determined by analysis the presence of carbon not combined as carbonates to an amount of 0.05 per cent. in the igneous, titaniferous magnetites near Lincoln Pond, Elizabethtown and has obtained traces in samples from two other mines. Gneisses were located near these intrusions but no limestones have been discovered nearer than several miles.

From the above it is evident that in the cases of the pegmatite veins and included bunches of silicates in the limestones, the carbon of the graphite has been introduced into its present situation in some migratory and penetrating form and that it has permeated the crevices of the rocks. The interesting point is whether it has probably come from the intruded magmas, or whether under the metamorphic processes of a regional character as well as of a contact nature it has been produced from carbonaceous matter originally in the sediments. Despite the occurrence of very small amounts in the igneous rocks, my own opinion from the preponderating evidence is that it has been derived from the limestones, quartzites and gneisses and has only been worked over, caused to migrate and recrystallize by the metamorphosing agents. The practical limitation of the graphite in large amount to the limestones and gneisses seems to me to favor this decision, but I am free to admit that the other view has some points in its favor. There is no question that some conditions, analogous to those which favor the production of pegmatites have been necessary to yield the coarse leaves. Aside, however, from the question of origin, abundant experience has proved the value of graphite as an indicator of sediments even if it be not derived from them, and as a sort of 'type fossil' it is most useful.

Conclusion.—In conclusion the more important points of our recent work upon the Adirondack sediments may be summarized as follows. They have been shown to be much more widely distributed than we formerly appreciated, but they are absent from a wide central area, where only massive gneisses and eruptive rocks have thus far been met. That the sediments were extensive is apparent from the evidence and from the thinness of the limestones on the east as well as their association with demonstrable quartzites, we infer that the clastics were deposited in much greater amount than has been realized. Both the nature of many gneisses and also these general considerations lead us to infer that shales or related rocks have been likewise present. On the east at least we have not yet been able to prove that the sediments form synclines, pinched into underlying gneissoid rocks. On the contrary they seem to constitute low dipping faulted monoclines.

All the sediments are thoroughly recrystallized and metamorphosed and the associated igneous rocks are plutonic or deep-seated types. Both these facts indicate their former burial at very considerable depths, and the subsequent removal of some thousands of feet by erosion. The next later rocks, of whose geological age we are assured, are the Potsdam sandstones, which lie on the old crystallines with dips seldom if ever more than ten degrees and which are not seriously metamorphosed. The greatly metamorphosed sediments are certainly pre-Potsdam and the large tectonic relations of the Georgian strata in Vermont to the Potsdam and the crystallines preclude our considering the latter as of possible early Cambrian age. We are forced to conclude therefore that they are pre-Cambrian, and from the comparatively unmetamorphosed condition of the Cambrian beds, we infer that the pre-Cambrian strata suffered their metamorphism in pre-Cambrian time. They may be taxonomic equivalents of the Huronian, but we have no good grounds for correlation.

The evidence regarding the Cambrian as interpreted by Walcott in the Champlain valley, leads us to believe that the Cambrian sediments encroached from the eastward upon the area of the crystallines. The Georgian is only found in Vermont. The Potsdam alone appears on the western side of Lake Champlain. It was not therefore any load of Paleozoic sediments, which rendered possible the deep-seated metamorphism of the pre-Cambrian sediments and the plutonic textures of the intrusions, but a load of pre-Cambrian rocks which have since disappeared. What those rocks were is an interesting subject of speculation.

They may have been sediments, whose disappearance leaves us with a lost interval. If so there is a gap in the records, which would be more comprehensible if we had better evidence of tight folds in our pre-Cambrian sediments and not the comparatively flat beds of limestone so often seen.

They may have been fragmental ejectments and vast surface flows of lava from centers of eruption whose deep-seated roots alone remain to us in the anorthosites, gabbros and syenitic rocks and whose materials piled up in the not unreasonable thicknesses of some thousands of feet, have been in time removed to contribute to the Cambrian or still earlier but undiscovered strata. Certainly the period of erosion was long and the results pronounced.

Bearing these consideration in mind, sometimes while seated upon a lofty peak of the mountains and while reflecting on the scene spread out in every direction, I have allowed my fancy free play and have pictured again the cones and vents that probably made of the Adirondacks a volcanic center comparable with Lake Superior. Beginning with eruptions of medium composition, as we know from the oldest igneous rocks now present they passed to more acidic types and closed with the basic gabbros. The fires seem then to have cooled and long erosion ensued.

Meantime beneath the piles of igneous rock, metamorphism from the hot intrusions and from the general rise of the isogeotherms went steadily forward, and the ancient sediments, whether calcareous or clastic, were changed over to marbles, quartzites and gneisses. Their carbonaceous matter became destructively distilled and penetrated every available crevice. In time it was changed to graphite. It even wandered over to the neighboring, partly cooled, igneous rocks and took part in the formation of the pegmatites.

Gradually the early Cambrian sea crept

up on the flanks, first attacking them in Vermont. The Ordovician sea followed and its sediments reached points well into the crystalline area. Pursuing the thought further we may raise the query, were the crystallines then reduced to a base-level and did submergence gradually bury them, and did the Ordovician sea and the subsequent Silurian sea go all across from side to side with a continuous mantle of sediments? Or were the crystallines a great island during all this time and have they remained so with minor faultings and upheavals to the present? These are questions easy to ask and difficult to answer. The most that we shall say about them now is that they are another story.

J. F. Kemp.

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ON KATHODE RAYS AND SOME RELATED PHENOMENA.

II.

The view here briefly formulated, although first suggested by Wiechert, owes its development chiefly to J. J. Thomson. The number of instances in which its consequences are at least qualitatively confirmed is already surprisingly large. Thus it has been known for some time that a wire or carbon filament, when heated to incandescence in vacuo, sends off negatively charged particles. Thomson * has recently shown that the ratio e/m for such particles is the same as for the kathode rays. Many metals also are capable of giving off negatively charged particles when illuminated by ultra-violet light; at sufficiently high vacua, rays may be produced in this way which possess all the essential properties of the ordinary kathode rays.† In this case also, the ratio e/m is found to be the same.‡ In these cases we have an indication that the corpuscles may be separated from the molecules of a substance by processes different from those which occur at the kathode. That intense heat, on account of the violent collisions between molecules, should make it easier for the corpuscles to escape, is quite natural. And that the rapid electrical vibrations set up by light, especially by that of short wave-lengths, should produce a similar effect, agrees equally well with the corpuscular hypothesis.

* *Phil. Mag.*, 48, p. 547, 1899.

† Merritt and Stewart, *Physikalische Zeitsch.*, 1, p. 338, 1900.

‡ Thomson, *Phil. Mag.*, 48, p. 547, 1899.

If the light radiated by a molecule of gas is due to the vibration or orbital motion of these charged corpuscles, a highly concrete and satisfactory explanation is at once obtained of the Zeeman effect. The theory has shown itself capable of accounting not only for the comparatively simple phenomena first observed, but also for the more complicated modifications of the spectral lines detected later. The ratio e/m as determined from the Zeeman effect is of the same order of magnitude as that determined from observations on the kathode rays.

Perhaps the strongest confirmation of Thomson's corpuscular hypothesis is that afforded by the recent investigations, of the Becquerel rays. In 1899 it was found that some of these rays, notably those produced by certain preparations of radium, were deflected in passing through a magnetic field.* More recently, it has been found that the rays are electrostatically deflected† and that they carry a negative charge. In fact, they behave in all respects like kathode rays. Within the last few months the ratio e/m has been determined by Becquerel‡ and found to have approximately the same value as in the case of the Zeeman effect and the kathode rays.

* Meyer and v. Schweidler, *Phys. Zeitsch.*, November 25 and December 2, 1899. Giesel, *Wied. Ann.*, 69, 834, 1899. Becquerel, *Comptes rendus*, 129, p. 996, 1899.

† Dorn, *Abhandlungen d. Naturforsch. Gesell.*, Halle, March 11, 1900.

‡ *Comptes rendus*, 130, p. 809, March 26, 1900.

It appears, therefore, that the same rapidly moving corpuscles which form the kathode rays, and which give practically the only concrete explanation of the Zeeman effect, also form one constituent at least of the Becquerel rays. In the latter case it would appear that the escape of the corpuscles is a result of violent internal disturbances among the molecules of the active substance. Such disturbances may accompany a gradual change from an unstable molecular grouping to one that is more permanent. This view removes all difficulty concerning the source of energy of these rays, a question which a few years since caused a great deal of needless annoyance.

The Becquerel rays developed by a given active substance usually consist of a mixture of rays, differing widely in their various properties. Not all of these rays are deflected by a magnet. In some instances the rays are more similar to the X-rays than to kathode rays, both as regards their behavior in a magnetic field and their other properties. In such cases it seems to me probable that X-rays are in reality present. Some of the magnetically deflectable rays, which are nothing more than kathode rays, naturally fall upon the active substance itself. There is no reason why this bombardment should not result in the development of X-rays, just as it would in the interior of a vacuum tube. That Lenard's kathode rays are able to produce X-rays even in the open air has already been shown by Des Coudres.*

The hypothesis of electrified corpuscles has been employed, in a form which does not necessarily imply the extreme smallness of the particles considered, by numerous physicists. For example, Lorentz† found it useful in discussing the electrical and optical phenomena in moving bodies: while Helmholtz* has used it in his electromagnetic theory of dispersion. An explanation of metallic conduction analogous to that of electrolytic conduction has often been sought. Recently this subject has been developed quite extensively by Riecke† whose results appear extremely promising. The assumption of positive and negative ions, different perhaps from those of ordinary electrolysis, permits a very concrete qualitative explanation of a great number of well-known phenomena. Among these may be mentioned the various thermoelectric phenomena, the Hall effect, together with its thermal analogue, and the Thomson effect. Views similar to those developed by Riecke have recently been supported by J. J. Thomson.‡

Enough has been said to show that the hypothesis of electrified corpuscles has much in its favor. That the present form of the hypothesis is very incomplete and leaves much to be explained, no one would attempt to deny. But by means of it we have obtained provisional explanations, at least, of many complex phenomena; while the usefulness of the hypothesis as an aid to further investigation has already been amply demonstrated. Now that we recognize the futility of attempting an ultimate explanation of natural phenomena, can we demand more than this of any theory or hypothesis? Let us therefore adopt the new theory in those cases where its adoption leads to clearness and concreteness, and make use of it as long as it aids in the advancement of science. As our knowledge increases, the theory will be continually modified and improved. Sooner or later it will doubtless be found insufficient, and will be abandoned; and something better

* *Wied. Ann.*, 62, p. 134, 1897.

† Versuch einer Theorie der elektrischen und optischen Erscheinungen in bewegten Körpern. Leiden, 1895.

* *Wied. Ann.*, 48, p. 389, 1893.

† *Wied. Ann.*, 66, p. 353 and 545, 1898.

‡ *Nature*, May 10, 1900.

will take its place. Such is, and such ought to be, the life history of all scientific theory.

The more promising a new theory appears, the more is it deserving of a careful and critical scrutiny, both from its adherents and from its opponents. The hypothesis of electrified corpuscles, which is involved in the modified Crookes theory, has proved its right to a hearing. It now has a right to demand the severest of friendly criticism. An elaborate critical discussion of the theory would be out of place in an address of this kind, even if sufficient time for the purpose were available. I wish, however, to call attention briefly to some points in connection with the subject which I think have not previously received the attention that they deserve.

Let us compare, for example, the values of e/m determined by different observers. The discrepancies between the values obtained by Wiechert and by J. J. Thomson is not surprising, since they were the first determinations of this kind that had been made. As a preliminary test of the theory, the fact that results obtained by such widely different methods were of the same order of magnitude is eminently satisfactory. A number of new determinations have been made, however, during the past two years. Since the more recent determinations were undertaken with a full understanding of the necessary experimental precautions, we should expect a close agreement among their results. But discrepancies of considerable magnitude still remain. It appears to me that the variation in the values of e/m obtained by different observers is greater than can be accounted for by experimental errors. To bring out this point, and in the hope of getting some idea of where the cause of the discrepancy is to be sought, I have prepared the following table, which contains practically all the values of e/m that have been obtained by experiments upon the kathode rays. Some of the values obtained by other methods have also been added for comparison.

The values of e/m are arranged in groups according to the method by which they were determined. The results of the most recent experiments, and presumably, therefore, the most accurate ones, are in each case placed last.

Leaving aside the results of Schuster and Wien and the first results of Wiechert, all of which were obtained by experiments of a purely preliminary character, we see that the results obtained by different observers show a satisfactory agreement, *provided that the same method was used.* Compare, for example, the two results of Kaufmann, obtained by different modifications of the same method, with that obtained by Simon. A more satisfactory agreement could scarcely be desired. Similarly, the values obtained by Lenard agree quite well with those that were obtained by J. J. Thomson when using the same method. But the smallest value obtained by the first method is twice as great as the largest value obtained by the last method. The results obtained by the second and third methods agree fairly well with each other, and are intermediate between the two extremes just mentioned. Wiechert's later determinations, however (Method III.), are subject to a possible constant error, so that these results must be regarded as uncertain.* The third method is liable to experimental error for several reasons, notably because its results are especially likely to be influenced by the conductivity of the residual gas. The effect of this source of error, as pointed out by Thomson, would be to make the results larger than they should be. Objections might also be raised to the assumptions on which the method is based. On the whole, it appears to me that the results of the first and fourth methods are to be

* *Wied. Ann.*, 69, p. 739, 1899.

regarded as the most reliable. And yet these are the methods whose results differ most widely.

As the difference appears too great to be explained by the accidental errors of observation, it is natural to seek its explanation in the assumptions upon which the two methods are based. Both methods employ the magnetic deflection of the rays and assume the same relation between deflection and velocity. But in the method of Kaufmann and Simon it is assumed that the whole potential energy of the corpuscle when at the surface of the kathode is transformed into kinetic energy of translation; *i. e.*, retarding forces due to friction or other causes are assumed to be entirely absent. The method has been criticised on that account by Schuster.* The effect of

VALUES OF e/m FOR KATHODE RAYS.

(The results are expressed in c. g. s. electromagnetic units.)

Observer.	Date.	Remarks.	Velocity. [Velocity of Light = 1].	$e/m \div 10^6$
I. Magnetic deflection and kathode potential. $Hev = \frac{mv^2}{r}$. $\frac{1}{2}mv^2 = eV$.				
Schuster.	1890			[1.1]
Schuster.	1898	Revision of former data.		[3.6]
Wiechert.	1897		About 0.3	[Less than 40]
Kaufmann.	1897	Used different gases and kathodes. Holtz machine.		17.7
Kaufmann.	1898	Holtz machine.		18.6
Simon.	1899	Holtz machine.		18.65
II. Magnetic deflection and velocity of rays. $Hev = \frac{mv^2}{r}$. v determined by the method of Des Condres.				
Wiechert.	1897		0.1	[20 — 40]
Wiechert.	1899	Hydrogen.	0.132 — 0.167	11.9 — 14.2
III. Magnetic deflection; heat developed; charge carried. $Hev = \frac{mv^2}{r}$. $\frac{1}{2}Nmv^2 =$ heat. $Ne =$ charge.				
J. J. Thomson.	1897	Different gases used. Induction coil.	0.077 — 0.12	10 — 14.3
IV. Magnetic deflection and electrostatic deflection. $Hev = \frac{mv^2}{2}$. $Hev = Fe$ [Two deflecting forces balanced].				
J. J. Thomson.	1897	Several gases. Induction coil.	0.077 — 0.4	6.7 — 9.1
Wien.	1898	Lenard rays.	About 0.3	[20]
Lenard.	1898	Lenard rays. Induction coil.	0.22 — 0.27	6.32 — 6.49

e/m from Zeemann effect.	(Various observers)	10 — 30
" " Ultraviolet light discharge.	J. J. Thomson.	5.8 — 8.5
" " Edison effect.	J. J. Thomson.	7.8 — 11.3
" " Becquerel rays.	Becquerel.	About 10.

The symbols used in the formulæ have the following significance: e = charge carried by each corpuscle; m = mass of corpuscle; v = velocity; N = number of corpuscles; H = strength of magnetic field; F = strength of electric field; r = radius of curvature of the rays when deflected in a magnetic field.

* *Wied. Ann.*, 65, p. 877, 1898.

neglecting the influence of retarding forces when such are really present would be to give values of e/m that are larger than the true value. For this reason, Schuster looked upon the method as giving merely a superior limit for the ratio. The experiments of Lenard make it unlikely that retarding forces can be present after the rays have emerged from the dark space. But it appears to me that in the immediate neighborhood of the kathode their equivalent might well be present. Before the electrified corpuscles can yield to the repulsion of the kathode and fly off to form the kathode rays, they must be torn loose from the molecules of which they form a part. Is it not possible that an appreciable fraction of the whole potential energy is expended in effecting this separation? Again, although it is certain that the kathode rays start from points very close to the kathode, have we any reason to suppose that they originate *exactly* at the surface? If the rays start a little in front of the kathode, the effect is the same, so far as the results obtained by Schuster's method are concerned, as if the corpuscles were subjected to retarding forces.

The most serious reason for doubting the correctness of the values obtained for e/m arises from the almost incredible velocity of the kathode rays. What right have we to suppose that ordinary electrical and mechanical laws are applicable to a particle moving at one-third the velocity of light? It appears to me that we have before us the most stupendous piece of extrapolation in the whole history of physics. Let us consider briefly the assumptions that are made and their experimental basis. The chief assumptions are as follows:

(1) The force exerted upon a corpuscle when passing through a magnetic field is proportional to the speed, being equal to Hev, where H is the field strength, e the charge, and v the speed.

(2) The force exerted upon a corpuscle when passing through an electric field is the same as though the corpuscle were at rest.

The experiments of Rowland and Himstedt afford indirect experimental evidence that the law stated in (1) is true for velocities up to about 10,000 cm. per second. In computing e/m the assumption is made that the same law holds for velocities a million times greater!

So far as I am aware, the question of the force exerted upon a moving charge by a stationary electrostatic field has never been made the subject of direct experimental inquiry. Lenard,* however, has made some experiments upon the kathode rays themselves which are of the greatest importance in connection with this question. Upon passing the rays through an intense electrostatic field in a direction parallel to the lines of force, he found that the rays were either accelerated or retarded according to the direction of the field. The change in velocity was determined by measurements of the magnetic deflection and was in some cases as great as fifty per cent. The observed change was the same in amount as would be expected if the force upon the charged corpuscles was the same as though they were at rest.

The dynamics and electrodynamics of a charged body in rapid motion have been attacked from a theoretical standpoint by J. J. Thomson,† Heaviside,‡ and Schuster.§ Rowland‖ has recently called attention to the fact that this is a case for the application of an extremely fundamental scientific law, namely, that of the 'conservation of knowledge.' Our real knowledge of the subject, based upon experiment, is practic-

* *Wied. Ann.*, 65, p. 504, 1898.

† Recent Researches in Electricity and Magnetism.

‡ Electrical Papers, Vol. 2.

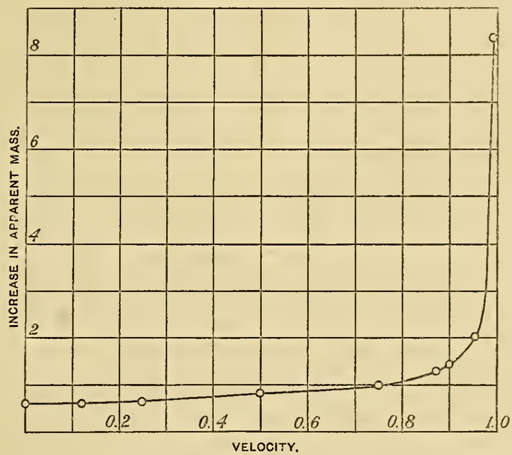
§ *Phil. Mag.*, 43, p. 1, 1897.

‖ Presidential Address before the American Physical Society, *Bulletin of the American Physical Society*, Vol. I., No. 1.

ally *nil:* no amount of analytical manipulation, however complicated, will add to it one iota.

In the present condition of our experimental knowledge, theoretical discussions of this nature are indeed pure speculation. But we must remember also that scientific speculation has always been one of the most important aids in the advancement of science. For a visionary enthusiast speculation is a plaything, dangerous to himself and annoying to others. But in the hands of the trained and conservative scientist it is a valuable tool, without whose aid the progress of knowledge would be slow indeed. The present case is one to whose study scientific speculation is particularly applicable. The motion of charged bodies at a speed nearly equal to that of light is a subject that we cannot hope to study by direct experiment. If we ever get a knowledge of the laws that apply in such cases, it must be by indirect methods. It is therefore simply a question of trying one hypothesis after another, deriving the consequences of each, and testing the conclusions by experiment. The kathode rays and the Becquerel rays offer the means by which such tests may be applied.

Although the theoretical results of Thomson and Heaviside are not in complete agreement, they both indicate considerable deviations from simple laws when the speed approaches that of light. Thomson states his results in convenient form by saying that the effect of a charge is to increase the apparent mass of the moving body. So long as the speed is small, the increase is inappreciable. But at high speeds it becomes important, and at the velocity of light the apparent mass becomes infinite. Since the effective mass is a function of the speed, we might therefore expect the ratio e/m to vary with the velocity of the kathode rays. But the hope of explaining the observed discrepancies in this way is illusory, as the apparent mass remains practically constant until the speed is nearly equal to that of light. The manner in which the apparent mass varies



with the speed, as computed according to Thomson's theory, is shown in the accompanying curve. Ordinates represent the apparent increase in mass, while abscissæ give the corresponding speeds. The speed of light is put equal to unity. It will be noticed that the ordinates remain nearly constant up to a speed of about eight-tenths that of light, after which the variation is rapid. In quantitative experiments on the kathode rays the speed has never exceeded one-half that of light. Previous experiments therefore afford no opportunity of testing the theory. The problem of increasing the speed still further is certainly a most promising subject of experimental investigation.

Since the apparent increase in mass is due to the energy of the field moving with the charge, it would appear that the amount of the increase must depend upon the form of the tube through which the rays pass. So far as I am aware, no experiments have heretofore been made to test this point. It may be that the variation, if it exists, is too small to be detected.

The suggestion has recently been made that perhaps the whole mass of the corpuscle is fictitious; that we really have to do with free electric charges, or electrons, existing apart from matter. This view is even more startling than that which makes the corpuscles smaller than atoms. The novelty of the suggestion is certainly not to be regarded as a serious objection. But direct experimental evidence in favor of this view is as yet lacking. Here, too, it appears to me that a quantitative study of the kathode rays *at the greatest attainable velocities* offers the most promising means of testing the theory.

We see that in this subject, as in every branch of natural science, each step in advance suggests still more important problems for further study and aids in their solution. In the kathode rays we have gained a new weapon with which to attack the great problems of ether and matter. What results will be achieved no one can predict. But great as have been the advances during the past decade, we can scarcely doubt that the progress during the decade that is just beginning will be even greater.

Ernest Merritt.
Cornell University.

MATHEMATICS AND ASTRONOMY AT THE AMERICAN ASSOCIATION.

The meeting of Section A was arranged with a view to complete co-operation with the Astronomical and Astrophysical Society in the astronomical part of the program and with the American Mathematical Society in the mathematical part. The full effect of such co-operation was secured by means of joint sessions, Section A meeting in joint session with the Astronomical Society on Tuesday and on Wednesday morning, and with the Mathematical Society in joint session or as guests, Wednesday afternoon, Thursday, and Friday. From this arrangement Section A received the benefit of adding to its program the papers of the two affiliated societies and having the presence of their members in its meetings while in turn, it gave the same aid to them. It is to be hoped that every year in which it is practicable some such arrangement for co-operation may be made.

Reports of the meetings of the Astronomical and Astrophysical Society and the American Mathematical Society will be published separately, hence it would be out of place to here discuss any of the papers presented by them. Among the papers of Section A, that of Henry S. Pritchett, who is leaving the Superintendency of the Coast and Geodetic Survey to become President of the Massachusetts Institute of Technology, is of perhaps the widest general interest; it is on the 'Functions, Organization and future Work of the U. S. Coast Survey.'

Dr. Pritchett divided his paper into three parts.

1. What is the purpose of the Service? The principal purpose he says is to make complete surveys and charts of the coasts of the United States. Added to this is the work of geodesy and the magnetic observations on land and sea.

2. Is it properly organized to carry out this purpose?

In the original organization the work was mostly in the hands of the army and navy. There has, however, been a complete change in this and with July 1, 1900, the Survey becomes entirely civilian. Within the last three years there has been a reorganization with the idea of developing a clear line of responsibility from the head of the service to each employee and with the further purpose of dividing the work so as to secure a more direct supervision of it.

3. What lines of work should it follow to accomplish the purpose in view?

The work has been planned as follows: First, a re-survey of parts of the mainland of the United States coasts and surveys of the coasts of Porto Rico, Hawaii, the Philippines, and Alaska. Second, the completion of an arc extending along the ninety-eighth meridian from the Rio Grande to the Canadian border, and the completion of the precise level net for the United States. Third, a general magnetic survey of the country and the waters adjacent.

Another paper of great interest and importance was Dr. G. A. Miller's 'Report on Groups of an Infinite Order.' The theory of groups in mathematics is of recent development but has assumed a place of fundamental importance. It is to reports from those who have made a special study of groups that we must look for an adequate survey of the subject as it stands to-day. Section A is especially fortunate in having had three reports which are supplementary to each other, at the last three meetings; the first of these reports was given at the Boston meeting by Dr. G. A. Miller and was on 'The Modern Group Theory'; the second, 'Report on the recent Progress in the Theory of Linear Groups' was given by Professor L. E. Dickson at Columbus, and the third is the one whose title is given above.

The following is the list of papers read before Section A:

'Miss Catherine Wolf Bruce,' by Miss Mary Proctor.

'Report on the Work of the Columbia College Observatory,' by J. K. Rees.

'Variations of Latitude,' by G. A. Hill.

'The Functions, Organization and Future Work of the United States Coast and Geodetic Survey,' by H. S. Pritchett.

'The Precise Level Net of the United States and a New Levelling Instrument,' by J. F. Hayford.

'New Light on Ancient Eclipses,' by J. N. Stockwell.

'The Case Almucantor,' by C. S. Howe.

'Standards of (faint) Stellar Magnitudes,'* by E. C. Pickering.

'Variations of Brightness of Stars in *m* 3,'* by S. J. Bailey.

'On the Spectroscopic Determination of Motion in the Line of Sight,' by W. W. Campbell.

'The Velocity of Meteors from the New Haven Observations,'* by W. L. Elkin.

'Parallax of Stars with Large Proper Motions,'* by F. L. Chase.

'On the Prediction of Occultations,'* by G. W. Hough.

'The Comparative Accuracy of the Transit Circle and the Vertical Circle,' by G. A. Hill.

'The Propagation of the Tide Wave,' by T. J. J. See.

'The Dimensions and Density of Neptune,' by T. J. J. See.

'Photometric Observations of Eros,' by H. M. Parkhurst.

'Secular Variations of the Motions of the Planets,' by J. N. Stockwell.

'A New Method of Finding the La Place Coefficients in the Theory of Planetary Perturbations,' by J. N. Stockwell.

'On a Method of photographing the entire Corona, employed at Newberry, S. C., for the total Solar Eclipse, May 28, 1900,' by W. G. Levison.

'Some Remarkable Properties of Recurring Decimals,' by Edgar Frisby.

* Astronomical and Astrophysical Society paper.

'History of the Complex Number,' by G. T. Sellew.

'The Motion of a Top taking into account the Rotation of the Earth,'** by A. S. Chessin.

'Kelvin's Treatment of Instantaneous and Permanent Sources extended to certain cases in which a Source is in Motion,'** by James McMahon.

'Oscillating Satellites',** by F. R. Moulton.

'On a Mechanism for drawing Trochoidal and allied Curves,'** by F. Morley.

'On Surfaces sibi-reciprocal under those contact Transformations which transform Spheres into Spheres,'** by P. F. Smith.

'On Singular Transformations in the Real Projective Group of the Place,'** by H. B. Newson.

'Report on Groups of an Infinite Order,' by G. A. Miller.

'On the Metabelian Groups whose Invariant Operators form a Cyclical Subgroup,' by W. B. Fite.

'Definitions and Examples of Galois Fields,' by L. E. Dickson.

'Construction Problems in non-Euclidean Geometry,' by G. B. Halsted.

'The Expression of a Rational Polynomial in a Series of Bessel Functions of the nth Order,' by James McMahon.

'Sundry Metrical Theorems connected with a special Curve of the 4th Order,' by F. H. Loud.

'The Directive Force of Philosophy upon Mathematics,' by Miss M. E. Trueblood.

'Die Hesse'sche und die Cayley'sche Curve,' ** by Paul Gordan.

'On the Rational Quartic Curve in Space,'** by F. Morley.

'On a Special Form of Annular Surfaces,'** by Virgil Snyder.

'On Hyper-complex Number Systems,'** by H. E. Hawkes.

'Application of a Method of d'Alembert to the Proof of Sturm's Theorem of Comparison,' ** by Maxime Bôcher.

'Theorems on Imprimitive Groups,'** by H. W. Kuhn.

'A Simple Proof of the Fundamental Cauchy Goursat Theorem,** by E. H. Moore.

'On the Existence of the Green's Function for simply connected plane Regions bounded by a general Jordan Curve, and for Regions having a more general Boundary of positive Content,'** by W. F. Osgood.

'Quaternions and Spherical Trigonometry,'** by J. V. Collins.

'The Reduction of Binary Quantics to Canonical Form by Linear Transformation,'** by Miss B. E. Grow.

** American Mathematical Society paper.

'Some Remarks on Tetraedral Geometry,'** by H. E. Timerding.

Organized discussion of the question, What courses in Mathematics should be offered to the student who desires to devote one-half, one-third, or one-fourth of his undergraduate time to preparation for graduate work in Mathematics.** Opened by J. Harkness, E. H. Moore, F. Morley, W. F. Osgood and J. W. A. Young.

Wendell M. Strong,
Secretary.

PHYSICS AT THE AMERICAN ASSOCIATION.

It was happily arranged this year that the Physical Society should meet with Section B, and this contributed to ensure a better attendance than was at first anticipated.

There were 29 papers presented before Section B, and 13 before the Physical Society. All but four were read.

The prominent characteristic of the papers presented was the care and thoroughness with which the experimental work forming the basis of the communications had been carried out. In this we see the influence of the German University training which so many of our physicists have received, but in addition to this there is superadded an ingenuity, and an adaptation of means to an end which is peculiarly American, and the result is a series of papers of the most admirable character.

Possibly the paper which excited most general interest was that of Professor R. W. Wood, on the 'Photography of Sound Waves.' The excellent photographs of the sound waves themselves, in practically every phase of transmission and reflection, and the kinetoscopic reproductions of their movement certainly marked an epoch in the history of the subject. A second paper 'On the application of the Schlieren method to the microscope,' illustrated a method apparently destined to be of the greatest value.

Another extremely valuable paper was that of Dr. Bedell, on 'Copper Saving in

** American Mathematical Society paper.

the Joint Transmission of Direct and Alternating Currents.' The author showed that when direct and alternating currents are sent over the same line, each behaves as if the other were not there, and that thus the same line can be used for two separate systems of transmission of energy, at the cost of a single line. This would seem to remove the last objection to the general use of the alternating current system and it is probable that the method will be extensively used.

In a paper on the 'Visible Radiation from Carbon,' Professor Nichols brought out the surprising fact that the radiation from carbons of the types used in incandescent lamp filaments is not, as has hitherto been generally assumed, of the same type as that from a perfectly black body, but that the radiation is *selective*, the radiation from that part of the spectrum between the red or the yellow being much greater than it is in the case of a black body. It thus becomes impossible to estimate the temperature of heated carbon from its radiation, but on the other hand a number of questions of the greatest interest are opened up which we may hope Professor Nichols' further researches will explain and which will result in considerable extensions to our knowledge of the subject.

In a paper by Professors Guthe and Trowbridge on the 'Coherer,' the authors find that their experiments on the properties of contacts can all be expressed by a single differential equation. A large number of facts are thus simply correlated, and a striking advance made in the theory of the subject.

Of a paper by Frank Allen on the 'Effect upon the Persistence of Vision of Exposing the Eye to Light of Various Wave Lengths,' in which a method suggested by Professor Nichols was used, it can only be said that it is one of those papers in regard to which, notwithstanding the apparent absence of all flaws in the admirable experimental work we are forced to reserve our opinion, since the results obtained are so utterly at variance with our preconceived ideas. No one, for example, who has done much spectro-photometry, would have anticipated that it would have been possible to obtain color curves of subjects on different days to an accuracy of less than two per cent. Again, the fact, brought out by the author's work, that an eye fatigued by yellow has its persistence altered for the red and green and not for the yellow which originally fatigued it, is apparently inconceivable.

But it is one of the fine things of science that it is perpetually impressing upon us the fact that we do not know everything yet, even in those cases where we are apt to feel that we can be most positive, so that the truly scientific man must be, at the same time very conservative, and yet capable of even greater efforts of mental gymnastics than Alice's White Queen, whom conscientious practice, in conjunction with shutting the eyes and breathing hard, had enabled to believe no less than six impossible things before breakfast. And it is quite possible that further evidence will show that we must really change our preconceived ideas in regard to color in a number of important respects. Accepting the experimental results, there would seem, as the author pointed out, no escape from the conclusion that the three fundamental color sensations are those of the red, green and violet. This is a most important result, and is to a certain extent corroborated by Mr. Ives, who in the course of a charming exposition of his three color processes during the meeting, took occasion to point out that the only screens which gave satisfactory results for such work were a red, a green and a blue-violet one.

Another very valuable paper was that by Merritt, on 'The Production of Kathode Rays by Ultra-Violet Light.' A charged disc was illuminated by ultra-violet light, and it was shown that negatively charged particles were thrown off which possessed the properties of the cathode rays in that they were reflectible by magnetism, carried negative charges and rendered air conducting. Crookes theory of the nature of the cathode rays is thus abundantly fortified. Merritt's Vice-Presidential address was on a similar subject, and evoked great interest.

In a paper on 'A New Theory of the Electromagnetic Rotation of Light,' the writer showed that whenever light is absorbed certain phase relations between the electric and magnetic forces and fluxes in the wave are shifted in such a way as to make the plane of the wave rotate when placed in a magnetic field, and evidence was given tending to show that this is a sufficient and probable explanation of the phenomenon.

A paper by Professor F. A. Bigelow on the method of reducing barometric observation was unfortunately read by title only, as it seemed, from the abstract, to contain some very valuable suggestions and data. Two papers were read by Professor Franklin, one on 'Lecture Room Demonstrations of the Elementary Theory of Elasticity,' in which some extremely ingenious methods of illustrating such phenomena were given; the other a more abstract and mathematical paper upon 'The Flow of Energy round a Conducting Screen near a Current Sheet.' Other papers read before this section were those of Anthony, 'An Observation upon the Surface Tension of Mercury'; Knipp, 'Surface Tension of Water above 100°'; Reed, 'On Temperature Effects on a Tuning Fork' (the last two containing a large amount of very valuable experimental data). Edward Atkinson read a paper on 'The Diffusion of Light,' treating the question from the standpoint of the manufacturer's and insurance company's standpoint. As Mr. Atkinson's work has been one of the chief determining factors in the method of lighting large factories in New England and elsewhere, his remarks were of more than general interst. He brought out the interesting fact that, whilst fire losses in the days of gas had been very high, electric lighting, installed under the regulations which he and his companies had drawn up, had brought them down to almost a negligible amount. The papers, 'The Percentage Bridge and its Applications,' by H. C. Parker; 'Power Curves from Alternating Current Circuits,' by Rosa; 'Circuit Breakers and Induction Coils' and 'Experiments in Electric Lighting' by the writer, covered various forms of apparatus. Some very beautiful photographs of electrical discharges were shown by T. B. Kinraide, and though the section did not apparently agree at all with his theories, all were united in their appreciation of the results obtained and of the apparatus used in their production. Other papers which may be mentioned are those by Professor Carhart 'On the Thermodynamics of the Voltaic Cell'; C. H. Williams, 'On an Improved Lantern for Testing Color Perception'; A. D. Cole, 'On the use of the Capillary Electrometer' describing an interesting modification, much more sensitive than the usual form; and the paper by I. S. Stevens, 'On a Method for Measuring Surface Tension.' As a whole it will be seen that the standard of the papers read was of a very high order, and of more than usual interest.

It will be impossible to more than mention a few of the papers which were read before the Physical Society: Reese, 'On Zeeman Effect'; Potts, 'On Electric Absorption in Condensers'; Dorsey, 'On the Polarization of the Solar Corona'; Nichols, 'Preliminary Tests on the Efficiency of Acetylene Flame as a means of Illumination'; Tufts, 'On Some Simple Apparatus for the Study of Aërial Vibration'; Knipp, 'On the Use of the Bicycle Wheel in Illustrating the Principles of the Gyroscope';

Rosa, 'On the Measurement of Alternating Electromotive Forces of High Potentials'; Bauer, 'On the Results of Simultaneous Magnetic Observations made at various points on May 28, 1900' and Wood 'On a Mica Echelon Spectroscope Grating' are some of the titles, which show that the meeting of this Society was fully as successful as that of Section B. Dr. Bauer's paper brought out the very interesting fact that at the time of the recent solar eclipse there was a distinct variation in the magnetic elements at a number of points on or near the line of totality, and that the change was not simultaneous, but depended upon the time of totality.

To sum up, it may safely be said that the admirable papers and admirable surroundings made the present meeting of the Section B one of the most enjoyable of recent years.

R. A. FESSENDEN,
Secretary.

SCIENTIFIC BOOKS.

The Cell in Development and Inheritance. By EDMUND B. WILSON. Columbia University Biological Series, Vol. IV. Second Edition. Revised and Enlarged. New York and London, The Macmillan Co. 1900. Pp. xxi + 483, with 194 figures in the text. Price, $3.50.

The appearance of the second edition of this already famous work gives occasion for calling attention not only to the changes which it has undergone, as contrasted with the first edition, but also to its general plan and character.

At the present time the greatest problems of biology are those which center in the life of the animal and plant cell. Assimilation, growth, metabolism, reproduction, inheritance, development and even evolution are subjects upon which the study of the cell has thrown a flood of light. The cell theory has indeed attained a prominence in modern biological work, second only to the evolution theory. The appearance, therefore, of a general work on the cell is of more than ordinary concern, not alone to the biologist, but also to all persons interested in the fundamental problems of biology.

Professor Wilson's work on the cell, the first edition of which appeared in 1896, at once took first rank among books on cytology. It is not only a general summary of the results of cell studies, but also a most important contribution to knowledge. The author has brought together, under one point of view the very many isolated observations and frequently conflicting views of a multitude of writers. In this he has graciously and entirely avoided the old museum idea of collecting material without reference to its use; although he touches upon almost every important work of modern times bearing upon the cell, yet the book is no mere encyclopedia of facts or theories—all is treated in a critical spirit as so much material to be builded into a system. The labor involved in this sifting of literature and collation of results must have been prodigious and all workers in these lines owe Professor Wilson a debt of gratitude for the service which he has thus rendered.

The general plan and scope of the second edition of this work remain unaltered; in fact the subdivisions into chapters and sections remain almost exactly the same as in the first edition. After an introduction in which is given a brief but suggestive sketch of the cell theory and its relation to the evolution theory, there follow in successive chapters: (1) A general sketch of cell structure; (2) cell-division; (3) the germ cells; (4) fertilization of the ovum; (5) oögenesis and spermatogenesis, reduction of the chromosomes; (6) some problems of cell organization; (7) cell chemistry and cell physiology; (8) cell division and development, and finally (9) some theories of inheritance and development. The volume also contains an excellent glossary, a general literature list, and indices of authors and subjects.

The most important changes in the second edition are found in those chapters and sections which deal with the nature and functions of the centrosome. For the past ten years this has been one of the most perplexing problems of cytology. In 1887 both Van Beneden and Boveri maintained that the centrosome was an independent and permanent cell organ, and Boveri held that the most important event in the fertilization of the egg was the addition of a centrosome to the egg cell, which before the entrance of the spermatozoon lacked a centrosome and was, therefore, incapable of division. Since then a large number of investigators have devoted attention to this subject with more or less conflicting results. In the first edition of his book on the Cell, Professor Wilson took a very positive stand in favor of the hypothesis of Van Beneden and Boveri; in the present edition he takes the much safer ground that the problem is still an open and unsolved one. As to the origin of the cleavage centrosomes he suggests (p. 230 *et passim*) that Boveri's hypothesis may still be maintained in a modified form if we assume that the sperm centrosome gives rise indirectly, through chemical stimuli, to the cleavage centrosomes.

Other important changes are found in the treatment of the structure of protoplasm, the mechanics of mitosis, and chromatic reduction, while minor alterations are found on almost every page. There are about 100 additional pages and more than 50 new figures, while several old figures have been redrawn and improved.

On the whole, the author's temper is much more cautious and judicial than in the first edition, while at the same time there is no loss of that enthusiasm which is the peculiar charm of his writing. The few erroneous statements of the first edition have been entirely rectified, and few, if any, new ones have crept in. Strange to say, however, the typographical errors have increased, though they are still few and for the most part unimportant. Too much praise cannot be given to the mechanical execution of the work. The illustrations are of the highest type of excellence; in fact it is no exaggeration to say that many of the figures are clearer and better than the originals (usually lithographs) from which they were taken.

The book mark of the Columbia Biological Series has been changed from a mitotic figure in the metaphase to one in the anaphase, which fittingly symbolizes the passing of this work from a first to a second edition. Although one of the latest books in this field, this is the first general work on cytology to pass through a second edition. May it see still other editions, telophases and yet other cycles of development, in the future!

Edwin G. Conklin.
University of Pennsylvania.

North American Forests and Forestry, Their Relations to the National Life of the American People. By Ernest Bruncken, Secretary of the late Wisconsin State Forestry Commission. New York and London, G. P. Putnam's Sons. 1900. Pp. vi + 266.

This work, which appeared early in the year, is a timely contribution to the much needed literature of forestry in North America. We have been so earnestly engaged in ridding the ground of the covering of trees which prevented us from 'planting corn to feed to hogs, to sell for money, to buy more land, to plant more corn, to feed more hogs,' etc., etc., that we have overlooked the fact that *a forest is often the best crop which a given area can produce.* With the disappearance of the great forest tracts we are learning the hard lesson that we have 'wasted our substance in riotous living,' and as the thoughtless prodigal of old finally 'came to himself' when he had spent all, so we are beginning to have different notions as to the value and importance of the heritage of trees which we so thoughtlessly wasted. This book is itself a result of this changed feeling. It is an attempt to treat the forest problems of the country as of such importance as to demand our most thoughtful consideration.

Some idea of the scope of the book may be obtained from the titles of a few of the chapters: The North American Forest, The Forest and Man, The Forest Industries, Destruction and Deterioration, Forestry and Government; Forestry and Taxation; Reform in Forestry Methods, Forestry as a Profession, etc. In the treatment of these topics the author discusses each with liberality, and is not given to urging his particular theory upon the reader's attention. In fact the book is very largely a calm discussion of forestry questions, and it is singularly free from long statements of the author's particular theories as to the proper solution of the problems in hand.

It should have a large sale throughout the country and should be found in every public library. Some one ought to make the experiment of using it as a supplementary reader in the high schools.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Catalogue of the Flora of Montana and the Yellowstone National Park. By PER AXEL RYDBERG, Ph.D. New York. 1900. 8vo. Pp. xii+492.

This fine volume, which is issued as the first volume of the Memoirs of the New York Botanical Garden, appeared early in the year, bearing date of February 15, 1900. It is the result of several seasons of work done in the field by the author as collector for the United States Department of Agriculture and the New York Botanical Garden. When he came to work up these collections he found that the flora of Montana was but little known, and accordingly he availed himself of all the accessible material of previous collectors. The final result is a list of 1976 species and varieties of Pteridophyta and Spermatophyta, of which 776 are not recorded in Coulter's 'Manual of the Rocky Mountain Region,' and 163 are new to science.

The treatment of the subject is liberal, and we have here much more than the old-fashioned list which has all but disappeared from botanical literature. The nomenclature is modern, of course, and authorities and descriptions are so freely cited that no one need have any difficulty in certainly identifying all of the species and varieties included. Habitat and locality notes are given with much fullness, and in nearly every case herbarium specimens are particularly indicated by numbers, the only exception being in those cases where the species had been authoritatively reported in standard works. The selection of type, the size of page, and quality of paper all contribute to the finish of the work for which the author supplied so well wrought a text.

The work includes 42 Pteridophytae, 21 Gymnospermae, 423 Monocotyledones, and 1490 Dicotyledones. The large families are Polypodiaceae (22 species), Pinaceae (20), Gramineae (191), Cyperaceae (105), Juncaceae (23), Liliaceae (28), Orchidaceae (22), Salicaceae (29), Chenopodiaceae (50), Amaranthaceae(27), Alsinaceae (34), Ranunculaceae (71), Crucifereae (76), Saxifragaceae (35), Rosaceae (84), Papilionaceae (122), Onagraceae (43), Umbellifereae (41), Primulaceae (24), Polemoniaceae (39), Boraginaceae (40), Scrophulariaceae (93), Compositeae, including Ambrosiaceae and Cichoriaceae (357).

That much work is yet to be done in this region may be seen from the author's remark in the preface that "the area east of the 108th meridian on the south side of the Missouri River, and of the 112th meridian on the north side is practically unexplored botanically," in fact it appears that it is only the mountain regions that have been fairly well explored.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

The Agricultural Experiment Stations in the United States. By A. C. TRUE and V. A. CLARK. U. S. Department of Agriculture, Office of Experiment Stations, Bulletin No. 80. Pp. 636, pls. 153.

This book was prepared as a part of the exhibit of the American Agricultural Experiment Stations at the Paris Exposition. It is an exhaustive treatise on the history, work, and present status of the experiment stations in general and of the fifty-six stations individually, profusely illustrated with half-tones showing the buildings, plats, laboratories, herds, etc., of the different stations. It opens with an account of the general agricultural conditions of the United States as related to the work of the stations, dividing the country into six general regions. The part devoted to the history of the stations includes an account of the early experimental work carried on by the agricultural colleges and other institutions prior to the establishment of experiment stations supported by State appropriation. The first of these stations was located at Middletown, Conn., in 1875, and was afterwards removed to New Haven, where it continues in operation. The movement to secure Federal aid for experiment stations, resulting in the passage of the Hatch Act in 1887, and the development of the stations under the Hatch Act are reviewed. There are now fifty-six stations in operation, including those in Alaska and Hawaii, fifty-two of which receive Federal aid.

The relations of the stations to the general government through the Department of Agriculture, their equipment, and lines of work are discussed at considerable length. Some of the more important general results of the work of the stations are briefly noted under the following headings: (1) Introduction of new agricultural methods, crops, or industrtes, and the development of those already existing; (2) the removal of obstacles to agricultural industries; (3) defense of the farmer against fraud; (4) aid to the passage or administration of laws for the benefit of agriculture; and (5) educational results of station work. Brief as this summary necessarily is, it brings out in a striking manner the wide range of usefulness of experiment stations to the farming community, touching nearly every phase of agricultural operation from the seeding and culture of the crop to its utilization in feeding for beef, pork, lamb or milk production, or in the arts. It points also to the great benefits which have already resulted in particular lines, as in the improvement of the dairy industry, which has been practically revolutionized, and is held by the authors to be "the most important general result of experiment station work"; the maintenance of soil fertility by the economical use of fertilizers and green manures; the introduction of new crops, as Kafir corn, rape and Mansbury barley; and the prevention of the ravages of a long list of injurious insects and diseases. And finally it brings out very forcibly the influence which the stations have had in arousing widespread interest in the various forms of agricultural education—a phase of the station work which is often underestimated. This influence has been exerted through the vast amount of literature distributed by the stations in the form of bulletins and reports, which go regularly into more than half a million homes and libraries, through other writings and correspondence of the station workers, their addresses at farmers' institutes, and the intimate association of the stations with institutions for higher education. "No nation has ever attempted the free dissemination of agricultural information in so wide and thorough a way as has the United States, and it is believed that the results have justified the large expenditures which have been made for this purpose. * * * The stations are not only giving the farmer much information which will enable him to improve his practice of agriculture, but they are also leading him to a more intelligent conception of the problem with which he has to deal, and of the methods he must pursue to successfully perform his share of the work of the community and hold his rightful place in the commonwealth." As a result of the intimate associations of the stations with institutions for higher education, "the pedagogical possibilities of instruction in the science and practice of agriculture have been more clearly revealed, and the claims of agricultural science have increasingly gained the respect and attention of scientists working in other lines. There is now in this country a much keener appreciation than heretofore of the fact that the problems of agriculture furnish adequate opportuuity for the exercise of the most thorough scientific attainments and the highest ability to penetrate the mysteries of nature."

The larger part of the volume is devoted of accounts of the individual stations, and of the Office of Experiment Stations at Washington, which constitutes a part of the general system. These accounts, although condensed, are quite complete, and aside from giving the history, equipment and lines of work of the station, contain many interesting notes on its more important and successful investigations, evidences of usefulness, and reference to general results which have been of greatest benefit to the agriculture of the State.

An appendix contains an account of the inspection work of the stations (fertilizers, foods and feeding stuffs, apparatus for milk testing, nursery stock, animal diseases, etc.), with the principal features of the laws under which it is carried on; the general statistics of the American stations; a list of the publications issued by them since their organization; a list of books published by experiment station workers; and a catalogue of the experiment station exhibit at the Paris Exposition.

The chief regret in connection with this book is the small edition to which it was limited, which precludes its general distribution, even among experiment station workers. It is hoped that Congress will see fit to authorize a reprint, so that it may be distributed to those most entitled to it, and placed on sale like other government publications.

E. W. ALLEN.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for July contains the following articles:

'Energy of the Cathode Rays,' by W. G. Cady.

'Volcanic Rocks from Temiscouata Lake,' Quebec, by H. E. Gregory.

'Interpretation of Mineral Analysis: a Criticism of recent Articles on the Constitution of Tourmaline,' by S. L. Penfield.

'Studies in the Cyperaceae, No. XIII,' by T. Holm.

'Titration of Mercury by Sodium Thiosulphate,' by J. T. Norton, Jr.

'Selenium Interference Rings,' by A. C. Longden.

'Carboniferous Bowlders from India,' by B. K. Emerson.

'New Bivalve from the Connecticut River Trias,' by B. K. Emerson.

'Statement of Rock Analyses,' by H. S. Washington.

'String Alternator,' by K. Honda and S. Shimizu.

'Action of Light on Magnetism,' by J. H. Hart.

THE June number of the *Bulletin of the American Mathematical Society* contains the following articles: 'Report of the April meeting of the Society,' by the Secretary; 'Report of the April meeting of the Chicago Section,' by T. F. Holgate, Secretary of the Section; 'On the history of the extensions of the calculus,' by J. G. Hagen; Burnside's 'Theory of groups,' by G. A. Miller; Shorter notices: D'Ocagne's 'Treatise on nomography,' by F. Morley; Barton's 'Theory of equations,' by J. Maclay; Rice's 'Theory and practice of interpolation,' by E. W. Brown; Braummühl's 'History of trigonometry,' and Boyer's 'History of mathematics,' by F. Cajori; and Frischauf's 'Series in circular and spherical functions,' by W. B. Ford; 'Notes'; 'New Publications.'

The July number, concluding Vol. VI. of the *Bulletin*, contains: 'Some remarks on tetrahedral geometry,' by H. E. Timerding; 'On singular transformations in real projective groups,' by H. B. Newson; 'On groups of order 8!/2, by Ida M. Schottenfels; Lobachevsky's Geometry' (second paper), by F. S. Woods; 'Burkhart's Elliptic functions,' by J. Pierpont; 'Erratum'; 'Notes'; 'New Publications'; 'Ninth annual list of papers read before the Society and subsequently published,' 'Index.'

DISCUSSION AND CORRESPONDENCE.

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

TO THE EDITOR OF SCIENCE: The following criticism has been sent to me of the last schedule published by the Royal Society for the International Catalogue:

"Take for example, paleontology, the introduction states that the zoological subdivisions are identical with those of the zoological scheme, but so hasty is the compilation that the old scheme of three years ago has been republished quite forgetful of the fact that it was long since given up and replaced by a totally different one. Had one ever classified titles by this scheme, the complete want of accord would have at once appeared. On p. 14 of the zoological scheme is a half page of misprints, which could not have been overlooked had the scheme served for experiments, 'Fauna and Flora' stands as a division of human anatomy, evidently through some carelessness of copying; topics are wanting in abundance and the same topic recurs 3 or even 4 times. Indeed in spite of all the good counsel given and the two years that have been taken, these last schemes simply swarm with errors, from fundamental ones to mere careless misprints * * *."

It hardly seems possible that this schedule, so regardless of the best principles of bibliographical work, and so illogical in its classification can receive the general support which is necessary to make it a financial success. We all welcome the idea of international co-operation as the only means out of the *impasse* of over crowded literature, but before we can combine we must have put before us a scheme which is practicable.

HENRY F. OSBORN.

THE CALLOSITIES UPON HORSES' LEGS.

TO THE EDITOR OF SCIENCE: I shall feel very much obliged to any of your readers who will furnish me with any hypotheses concerning the origin of the callosities upon the legs of horses and mules, and upon the fore-legs of asses. The idea that they are the remnant of the inner toe is, in my opinion, untenable, chiefly because this toe has been the first to disappear in all ungulates.

LAWRENCE IRWELL.

BUFFALO, N. Y., July 15, 1900.

TRANSMISSIBILITY OF ACQUIRED CHARACTERS.

TO THE EDITOR OF SCIENCE With reference to the difficulties in the way of such heredity mentioned by Professor Sedgwick in his address printed in your issue of the 6th of this month, would not modifications induced by diet during a whole lifetime have the greatest chance of being transmitted and becoming permanent in the race? By such experiment would not the reproductive cells be equally affected with the rest? These modifications could be influential during the whole lifetime, commencing even in the embryonic and antenatal stages. Thus the influence of ancestral and homochronous heredity would be, as far as possible, obviated. To learn if such a test has ever been attempted, and for any particulars, I should be much obliged.

C. G. S.

23 UP. BEDFORD PLACE, LONDON, W. C.
June 29, 1900.

CURRENT NOTES ON METEOROLOGY.

REPORT OF THE CHIEF OF THE WEATHER BUREAU.

VOL. I. of the annual Report of the Chief of the Weather Bureau has been issued. This volume contains the monthly and annual summaries for 1898, with the customary administrative report. In the latter, special attention is given to the West Indian service of the Weather Bureau. The following points seem worthy of note. In connection with the river and flood service it is stated that "during the next two years, if sufficient funds are available for the purpose, it is proposed to prepare a comprehensive work on the entire navigable water régime, giving a complete history of all river stations, elevations above tide-water, rate of flow of water, and data for flood forecasting." The health of the men in the West Indian division is stated to have been remarkably good. "Although almost all have suffered more or less from tropical fevers, and the debilitating effects of the climate, yet the continuity of observation has been interrupted by sickness only at Santiago."

THE AURORA AUSTRALIS.

IN *Ciel et Terre* for May 16th, Arctowski publishes a short paper on his observations of the aurora australis made during the recent trip of the *Belgica.* There were in all 62 observations. The phenomenon generally appeared between 7 p. m. and 2 a. m., the maximum intensity coming most frequently between 9 and 10 p. m. The maximum frequency did not come during the months of polar night, and the intensity was manifestly greatest at the equinoxes. Arctowski finds a striking similarity in the appearance of the aurora borealis as observed by Nordenskiold on the *Vega* in 1878–79, and described by him, and the aurora australis as observed on the *Belgica* expedition.

R. DEC. WARD.

HARVARD UNIVERSITY.

NOTES ON OCEANOGRAPHY.

THE DANISH 'INGOLF' EXPEDITION.

SINCE the publication of Mohn's great work on the results of the Norwegian Atlantic Expedition, the most important contribution to our knowledge of hydrographic conditions in the North Atlantic has doubtless been Knudsen's recent memoir (The Danish Ingolf Expedition, Vol. I., Part 1, Copenhagen, 1899). Knudsen has made a substantial improvement on the Negretti-Zambra deep-sea thermometer. While salinity determinations are of first importance in establishing the relations between the waters of the Gulf Stream Drift and Arctic currents, it is interesting to note that he did not use the hydrometer except as a check, but relied exclusively on the use of the chlorine coefficient, calculating the total salts from the amount of chlorine found in each water-sample by titration. He agrees with Pettersson that this convenient method gives the most accurate results. The gas analyses are especially numerous and valuable. The content of nitrogen has been used, in connection with temperature, to distinguish polar and Gulf stream water; the degree of 'supersaturation' of the surface-water with oxygen has been found to be in proportion to the abundance of diatoms and vegetable plankton in general, thus confirming the laboratory experiments of Knudsen on this subject. The 'Irminger' current of Nordenskiold has been delimited more clearly than heretofore; it follows the 'Reykjanaes Ridge,' skirts the southwest and west shore of Iceland, and then divides into two branches, one of which, turning to the southwest, completes the circuit of a large eddy that centers southwest of Iceland and is characterized by the cyclonic type of rotation. The other branch runs northward, hugging the Iceland coast, then eastward, and, north of the center of the island, dives beneath the surface. The complex stratification of the water east of this point, as well as in Denmark Sound and in Baffin's Bay, is illustrated in the memoir by a large number of sections. Pettersson reproduces some of these in his helpful discussion on recent works on this portion of the ocean (*Petermann's Mittheilungen*, pp. 1 and 25, 1900).

CURRENTS IN THE NORTH SEA.

DR. T. W. FULTON, the scientific superintendent of the Fishery Board for Scotland, has reported on the success which has attended his experiments with numerous bottle-floats to determine the currents of the North Sea. (Fifteenth Ann. Rep., Pt. III.) The circulation throughout the year seems to be that of a single great current which rounds the northern end of Scotland, turns southward, skirting the eastern coast of England to Yorkshire, and then turns eastward to the Danish shore, where it assumes a northerly trend. Part of the water enters the Skagerrack, but most of it goes to form the well-known coastal current of Southwest Norway. The explanation of this curved path is one of the problems which Dr. Fulton has set himself. The prevailing and dominant west and northwest wind cannot be the immediate motor, since it blows almost at right angles to the current with its north and south trends in British and Danish waters. Yet the wind is regarded as the indirect cause of motion. In the southeast portion of the sea there is banking of water by wind stress. Escape for the surplus water is impossible through the Strait of Dover on account of the small size of that opening, and a movement is instituted along the steeper surface gradient toward the north along the Danish shore. The remainder of the current curve is explained in largest part as the result of compensation of the movement just described. The earth's rotation may be accorded some share in turning the Gulf Stream water around the northern capes of Scotland, and in causing the clinging of the North Sea current so near to the shore as is actually the case. The influence of tidal streams is excluded by Dr. Fulton, chiefly on the ground that, on the east coast of Great Britain, the north-flowing ebb is stronger than the south-flowing flood.

THE GULF STREAM DRIFT.

DOES the Gulf Stream Drift persist on the surface at all seasons of the year through the Norwegian Sea? This question, so important to Norwegian fisheries, has, according to Hjort and Gran, been definitely settled. (Report on the Norwegian Marine Investigations, 1895–97, Bergen, 1899.) During the winter the relatively warm and dense 'Atlantic' water is partly displaced by the strengthened Arctic current which runs southeast past the east coast of Iceland, but does not reach the Shetlands. On the approach of summer the polar water retires from the surface and is not found south of Iceland. This annual periodicity in the Gulf Stream Drift is accompanied by changes of greater amplitude in time, but their laws have not yet been formulated. Detailed observations on the plankton organisms show that their occurrence has likewise a marked annual periodicity which is associated with that of the currents. Further proofs of a similar relation subsisting between the herring fisheries and current variations of periods ranging from one to several years, have recently been published by Pettersson and Ekman as one result of the international researches of 1894 and 1895 in the North Sea (Bihang till k. Svenska Vet.-Akad. Handl. 1890 Bd. 25, Afd. II, No. 1.)

HYDROGRAPHY AND FAUNAS OF SPITZBERGEN COAST WATERS.

A PRELIMINARY review of the material collected by the German Expedition to the North Polar Seas in 1898 has afforded some interesting conclusions as to the conditions of life in the waters about Spitzbergen (see *Fauna Arctica* edited by F. Römer and F. Schaudinn, Vol. 1, Jena, 1900). On the eastern side of the island the fauna is richer, species and individuals more numerous than on the west coast; in the former tract, moreover, the fauna is markedly benthonic, in the latter planktonic. These contracts are referred to the action of currents. While Gulf Stream water occupies the sea west and north of Spitzbergen it is intimately mixed with the cold water of the polar current on the east. In this zone of mixture the stenothermic and stenohalinic organisms of the plankton are killed, and thus furnish an abundant rain of food for the bottom forms. So thickly planted were the hydroids and bryozoa that at times the heavy dredge did not penetrate to the true bottom at all, but came up full of these organisms. A table of hydrographical observations appears in the narrative of the voyage.

Reginald A. Daly.

Harvard University.

A NEW STAR IN AQUILA.

From an examination of the Draper Memorial photographs, Mrs. Fleming has discovered a new star in the constellation Aquila. Its position for 1900 is R. A. $= 19^h\ 15^m\ 16^s$, Dec. $= -0°\ 19'.2$. It was too faint to be photographed on 96 plates taken between August 21, 1886, and November 1, 1898, although stars as faint as the thirteenth magnitude are visible on some of them. It appears on 18 photographs taken between April 21, 1899, and October 27, 1899. On April 21st it was of the seventh magnitude, and on October 27, 1899, of the tenth magnitude. Two photographs taken on July 7, and July 9, 1900, show that the star is still visible, and that its photographic magnitude is about 11.5. A photograph taken on July 3, 1899, shows that its spectrum resembled those of other new stars, while a photograph taken on October 27, 1899, shows that the spectrum resembled those of gaseous nebulæ.

On July 9, 1900, the object was observed with the 15-inch Equatorial by Professor Wendell, who estimated its magnitude as 11.5 to 12.0, and confirmed the monochromatic character of its spectrum.

E. C. Pickering.

Harvard College Observatory.

THE ESTABLISHMENT OF A BUREAU OF CHEMISTRY.

The following resolutions have been approved by Council of the American Chemical Society:

Whereas, the laws of the several states controlling food adulterations are largely ineffective because of the interference of interstate commerce laws, and can be made effective only through national legislation,

And whereas, by bills now pending in the Congress of the United States and particularly by bills numbered H. R. 9677 and Senate 2426, it is proposed to establish in the United States Department of Agriculture a bureau of chemistry, the director of which shall, under the direction of the secretary of agriculture, be charged with the chemical investigation of the foods produced and consumed throughout the country.

Therefore be it resolved by the Council of the American Chemical Society that the Congress of the United States be, and is hereby, urged to promptly enact into law the said bills, namely H. R. 9677, and Senate 2426, and provide adequate facilities for effective prosecution of the provisions of the said bills.

Resolved, further, that a copy of this resolution be forwarded to the president of the United States Senate; to the speaker of the House of Representatives; to the chairman of the Committees on Agriculture and on Commerce and Manufactures of the Senate of the United States; to the chairman of the Committee on Interstate Commerce of the House of Representatives; to the secretary of agriculture, who shall be charged with the enforcement of the provisions of said bills, and to the presiding officers of the various sections of the Society, urging their co-operation in the movement to secure the establishment of the bureau of chemistry, which shall be charged with the scientific and chemical work required in the enforcement of the provisions of the said bills.

SCIENTIFIC NOTES AND NEWS.

M. Giard has been elected a member of the Paris Academy of Sciences in the section of anatomy and physiology in the room of the late Milne-Edwards. He received 30 votes, 16 being cast for M. Delage and 12 for M. Vaillant. M. Dwelshauvers-Dery has been elected a correspondent for the section of mechanics and M. Oehlert for the section of mineralogy.

THE Berlin Geographical Society has elected honorary members as follows: Mr. Alexander Agassiz, Gen. A. W. Greely, U. S. A., Mr. Morris K. Jesup, President of the American Museum of Natural History, Professor James Geikie, and Professor Bidal de la Blache of Paris. The Society has conferred the gold and silver Karl Ritter medals on Dr. V. Semenoff of St. Petersburg and Dr. Hans Steffen of Santiago, Chile, respectively, and the gold and silver Gustav Nachtigal medals on Dr. W. Bornhardt of Clausthal and Dr. Hans Meyer of Leipzig. The Georg Neumayer medal, this year awarded for the first time, was bestowed upon Dr. Boergen of Wilhelmshaven.

THE Balbi-Valier prize (3000 fr.) of the Venetian Institute of Sciences has been awarded to Professor Grassi at Rome, for his work on the relation of mosquitoes to malaria.

THE Paris Academy of Moral and Political Sciences has awarded its Audifred prize of the value of 15,000 fr. to Dr. Yersin for the discovery of his anti-plague serum.

THE Royal Society of Edinburgh has elected the following to honorary membership: Professor Dr. G. F. Fitzgerald (Dublin), Professor Andrew Russell Forsyth (Cambridge), Professor Archibald Liversidge (Sydney), Dr. T. E. Thorpe (London), Professor Dr. Arthur Auwers (Berlin), Professor Wilhelm His (Leipzig), and Professor A. von Baeyer (Munich).

PROFESSOR FREDINAND V. RICHTHOFEN has been appointed director of the new museum of oceanography at Berlin, and Dr. P. Dinse of Charlottenburg has been called to fill the position of curator.

WESTERN RESERVE UNIVERSITY has conferred the degree of LL.D. on Mr. Charles F. Brush of Cleveland.

WE take the following items from the *American Geologist:* Mr. Alexander N. Winchell of Minneapolis, who has been the last two years studying at Paris in the laboratories of Professors Lacroix and Hautefeuille, has been elected professor of zoology and mineralogy in The New Montana School of Mines, Butte, Montana, and will return in time for the opening of the School in September. Professor J. E. Wolff of Harvard University who spent the larger part of last winter studying in Germany is expected to return to America during the latter part of August. Dr. H. Foster Bain, recently assistant State geologist of Iowa, has undertaken a reconnoissance of the zinc field at Joplin, Mo., for the U. S. Geological Survey.

DR. A. L. BISHOP, of Buffalo, has been given charge of the Department of Archæology and Ethnology to which the Pan-American Exposition at Buffalo is paying special attention.

THE English astronomer Royal Mr. W. H. H. Christie gave a reception at Greenwich Observatory, on July 2d, at which the equipment of the Observatory was viewed by a number of visitors.

WE regret to record the death of Dr. John Ashhurst, Jr., until last year professor of surgery in the University of Pennsylvania, and the author of many important contributions to surgery and medicine. He died from paralysis, in Philadelphia, on July 7th, aged 61 years.

SIR ROBERT MURDOCH SMITH, major-general of the Royal Engineers, and since 1885 director of the Edinburgh Museum of Science and Art, died on July 3d, at the age of 65 years. He had been engaged with Sir Charles Newton's archæological expedition to Halicarnassus, had conducted explorations in Cyrenicia and had charge of the Persian telegraphs.

MR. GEORGE WORKMAN DICKSON, colonial engineer of British Guinea, died at sea on June 10th.

THE New York Board of Estimate and Apportionment has authorized the expenditure of $200,000 for the Botanical Garden and $150,000 for an addition to the American Museum of Natural History.

WE have already stated that the magnificent collection of jewels arranged by Mr. George F. Kunz and exhibited by Messrs. Tiffany & Co. at the Paris Exposition has been presented to the American Museum of Natural History. It is now known that the donor is Mr. J. Pierrepont Morgan. This collection will be incorporated with the Tiffany-Morgan collection of gems presented to the American Museum of Natural History in 1899, and which formed the Tiffany collection of gems at the 1889 Exposition. The entire collection will be placed in a hall now being prepared for it in the new wing of the museum.

Milne Edwards has by his will bequeathed his library to the Paris *Jardin des Plantes* of which he was the director. It is to be sold and the proceeds to be applied toward the endowment of the chair of zoology which he held. He also leaves 20,000 fr. to the Geographical Society, of which he was president, for the establishment of a prize, and $10,000 to the *Société des amis des sciences*.

Trinity College library has received from Dr. G. W. Russell a complete copy of Audubon's 'Birds of America.' There are believed to be about 175 copies of the work about half of which are in America.

The University of Barcelona has employed M. Benlliure, an eminent Spanish sculptor, to make a bust in bronze of M. de Lacaze-Duthiers in recognition of his services to zoology and his hospitality to foreigners who have worked in the marine laboratories established by him. The bust is now exhibited at the Paris Exposition and will be presented by members of the University of Barcelona to M. de Lacaze-Duthiers in the buildings of the University of Paris during the present month.

The bronze monument in honor of Lavoisier by M. Barras will be unveiled at Paris on the 27th of the present month. The international subscription to the monument now amounts to $20,000. The monument in addition to the bronze statue of Lavoisier contains two bas-reliefs, one representing Lavoisier in his laboratory dictating to his wife, and the other Lavoisier explaining his discoveries to the Paris Academy of Sciences.

The *British Medical Journal* states that a monument has been erected to the memory of Dr. Jean Hameau, the obscure general practitioner of the Gironde who in 1836 published a study on viruses, in which he partly anticipated the discoveries of Pasteur. The statue was unveiled recently at La Teste de Buch, where Hameau practiced. Addresses were delivered by Dr. Laude, the Mayor of Bordeaux and President of the Medical Syndicates Union of France, Professor Lannelongue of Bordeaux and others. Hameau was born in 1779, and died in 1851.

The Conference on Malaria which the Liverpool School of Tropical Medicine had arranged to hold at the end of July, has been postponed on account of the date suggested clashing with the celebration of the Centenary of the Royal College of Surgeons of England and with other arrangements.

A new physiological society has been established in Vienna with Professor S. Exner as president.

The Ohio Geological Survey has been reorganized by the new State Geologist, Edward Orton, Jr., and is now as follows: Edward Orton, Jr., State Geologist, Economic Work in Cement and Clay Industries; Charles S. Prosser, Assistant Geologist, Stratigraphical and Areal Geology; John A. Bownocker, Assistant Geologist, Economic Work in Oil and Gas; Nathaniel W. Lord, Consulting Chemist, Economic Value of Ohio Coals; C. Newton Brown, Special Assistant, Uses of Portland Cement; Albert V. Bleininger, Assistant, Manufacture of Portland Cement; Ralph W. Nauss, Assistant in Chemical Laboratory. This summer Professor Orton and two assistants are fitting up apparatus for testing cements and he will spend some time in the field in Ohio and in visiting the leading cement works of other States. Professor Bownocker is studying the occurrence of oil and natural gas in eastern Ohio; and Professor Prosser is carrying on some stratigraphical field work in the Devonian and Carboniferous systems.

The members of the Palisades Commission of the States of New York and New Jersey made a tour of inspection on July 13th. It will be remembered that these Commissioners have power to select the land along the Palisades which could be used for establishing a park and preserving the beauty of the rocks. The park must, however, not approach nearer the river than 150 feet. No funds are provided for the purchase of the land, but the Commissioners may receive gifts and bequests.

SECRETARY HERBERT L. BRIDGMAN, of the Peary Arctic Club, left on July 12th, for Sydney, C. B., to superintend the departure, of the club steamer *Windward* for North Greenland, and if advisable, to take charge of the expedition. The *Windward* carries a full cargo of American flour, oil and sugar, Dominion coal and English pemmican, Maine lumber, New Bedford whaleboats and Mauser rifles from Santiago and will proceed as rapidly as ice and other conditions will permit to Peary's headquarters at Etah. The mail expected from the Norwegian friends of the Fram-Sverdrup expedition has not arrived, and the relief promised for the Robert Stein party landed last year, near Cape Sabine, has entirely failed to materialize. The fate of Stein and his companions depends upon the *Windward*.

TWO volumes of the evidence before The British Indian Plague Commission have been issued. They contain a large amount of testimony and numerous reports on preventive inoculation, and other subjects, but the report of the Commissioners has not yet been issued.

A MEETING was held at Liverpool on June 25th under the auspices of the School of Tropical Medicine at which the following resolutions were adopted :

1. That this meeting of the Liverpool School of Tropical Medicine and others, having heard the views of the experts of the School on the conditions for Europeans of life in the tropics, are strongly of opinion that steps should be immediately taken by Her Majesty's Government to improve those conditions in every possible direction by the segregation of Europeans, improved sanitation, better water supply, clearance of bush near towns, light railways to the mountainous districts, and such other means as science may direct. 2. That the Liverpool Chamber of Commerce be requested to co-operate with the School, and to ask the Government to receive a joint deputation on the subject.

Addresses on the subject were made by Professor Robert Boyce, Major Ronald Ross and Professor Flexner.

ACCORDING to a cablegram to the daily papers, the first authoritative report on Count Zeppelin's airship was made on July 10th at a meeting of the society for the promotion of aërial navigation by experts who either shared in or watched the recent experiment. They declared that improvements in the steering apparatus were necessary, the one at present used having been thrown out of gear on one side of the balloon, rendering its proper guidance and return to the starting point impossible. The steering rods running upward from the car were too weak and became bent. The screw blades consequently did not respond properly. The air pressure motors failed, but it was difficult to say whether this was caused by a defect or by bad handling. The method of transmitting power to the screws will need great improvement to enable the airship to contend against even a light wind. During the recent ascent the wind had a velocity of three metres a second to a height of 100 metres, and against this the vessel sailed well, but at a height of from 150 to 200 metres the balloon was evidently driven before the wind. It must be remembered, however, that this was when one of the rudders was out of gear. If the speed of the screws cannot be increased the blades must be enlarged. Another defect was the continual escape of gas, necessitating constant filling of the receptacle up to the moment of starting. This defect alone will prevent the achievement of the idea of remaining in the air for eight consecutive days, as a single filling costs 10,000 Marks. It is imperative for financial as well as scientific reasons that this defect be overcome. The king and queen of Würtemburg will visit Friedrichshaven on July 12th, when a second ascent will be tried in their presence. On the result will depend whether the vessel shall be improved on its original lines or fundamental alterations be made. The problem will certainly not be abandoned even if there is another failure. Count Zeppelin is far too enthusiastic to give up his attempts. Moreover, large financial interests are at stake. Already more than 1,000,000 Marks have been spent on the machine and experiments, of which amount Count Zeppelin furnished about 500,000 Marks.

THE annual general meeting of Marine Biological Association was held in the rooms of the Royal Society on June 27th. *Nature* states that the council reported that arrangements had been completed for the supply of sea-water, obtained from the open sea beyond the Plymouth Breakwater, for special experiments on the rearing of sea-fishes and other marine animals. Through the kindness of Mr. J. W. Woodall, the Association has had placed at its disposal a small floating laboratory, which is at present stationed at Salcombe. The periodical surveys of the physical and biological conditions prevailing at the mouth of the English Channel have been continued by Mr. Garstang at quarterly intervals for an entire year. Observations were taken at four fixed stations. They included serial temperature determinations at all depths, filtration of a definite column of water from bottom to surface with a 'vertical net,' and collections of the floating life at surface, mid-water and bottom by means of a special devised closing net. Mr. Garstang has also carried out a series of preliminary experiments on the rearing of sea-fish larvæ under different conditions, with a view to a solution of the difficulties hitherto encountered in regard to the practical work of sea-fish culture.

UNIVERSITY AND EDUCATIONAL NEWS.

For the eighth time, we believe, the courts have decided the Fayerweather will case in favor of the colleges. It is said that the case will still be carried to the Supreme Court of the United States. As the amount still involved is about $3,000,000 it is to be hoped that no legal technicality will prevent the money from being used as Mr. Fayerweather intended and that it will not be diverted to the distant heirs and the lawyers who are trying to get it.

A fellowship in Greek has been endowed at Columbia University to be open to graduate students in Barnard College. The name of the donor is not made public. The fellowship will carry with it an annual stipend for the holder of $500.

The foundation-stone of the Passmore Edwards Hall of the University of London, which is being erected on a site allocated for the purpose by the London County Council in Clare Market almost on the line of the projected new street from Holborn to the Strand, was laid on June 2d. The hall will furnish the home of the Faculty of Economics and Political Science (including commerce and industry), established by the University Commissioners, and in it will be carried on the future work of the London School of Economics and Political Science, which is practically coextensive with the new Faculty, and which has been admitted as a school of the University. Toward the expense of carrying on the work the London County Council will contribute £2500 a year, and Mr. Passmore Edwards has vested the sum of £10,000 in three trustees for the erection of the building and for carrying on the work of the School.

Dr. Winthrop E. Stone has been chosen president of Purdue University in Indiana as successor to Dr. James H. Smart, who died last spring. Dr. Stone has been vice-president of the university for several years.

Dr. Lewis G. Westgate has been appointed professor of geology in the Ohio Wesleyan University.

Dr. James M. Safford, who has been professor of geology in Vanderbilt University for many years, has just retired at the age of seventy. For half a century he has been State Geologist of Tennessee.

Dr. George P. Dryer, associate professor of physiology at the medical school of Johns Hopkins University, has been appointed professor of physiology in the Medical School of the University of Illinois.

Dr. Stephen Riggs Williams, an assistant in zoology at Harvard University and for two seasons instructor at the Cold Spring Biological Laboratory, has been appointed professor of biology and geology at Miami University, Oxford, Ohio, in place of Professor Treadwell, who has gone to Vassar College.

Dr. Justus W. Folsom, professor of natural science at Antioch College, Yellow Springs, Ohio, has been appointed instructor in entomology at the University of Illinois.

Mr. William Richard Sorley, professor of moral philosophy in the University of Aberdeen, has been elected to the Knightbridge professorship of moral philosophy at Cambridge University, in the place of Professor Henry Sidgwick who has been compelled to resign owing to ill health.

SCIENCE

FRIDAY, JULY 27, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

I.

THE second annual meeting of the Astronomical and Astrophysical Society of America (fourth conference of astronomers and astrophysicists) was held on June 26–28, 1900, at Columbia University, in the City of New York, in connection with the forty-ninth annual meeting of the American Association for the Advancement of Science.

A brief report was presented by the Secretary upon the action of the Council in administering the affairs of the Society during the past year showing an addition of forty-three members since the date of the last meeting. With one exception the officers of the Society whose terms of office expired at the present meeting were re-elected, and the list for the year 1900–'01 is as follows: *President*, Simon Newcomb, of Washington, D. C.; *First Vice-President*, Charles A. Young, of Princeton, N. J.; *Second Vice-President*, George E. Hale of Williams Bay, Wis.; *Secretary*, George C. Comstock of Madison, Wis.; *Treasurer*, Charles L. Doolittle of Philadelphia, Pa.; *Councillors*, Edward C. Pickering of Cambridge, Mass.; James E. Keeler of Mt. Hamilton, Cal.; Ormond Stone of Charlottesville, Va.; and Stimson J. Brown of Washington, D. C.

By direction of the Council the next annual meeting of the Society will be held in Denver, Col., in August, 1901.

In accordance with the expressed wish of the Society the Council adopted the following resolutions and directed the Secretary to transmit copies of them to the Chief of the Weather Bureau and to the Western Union Telegraph Company.

Resolved, That the Astronomical and Astrophysical Society of America extends to the Chief of the U. S. Weather Bureau its hearty thanks for his courtesy in transmitting daily weather bulletins to those astronomers who observed within the United States the total solar eclipse of May 28, 1900.

Resolved, That the Astronomical and Astrophysical Society of America extends to the Western Union Telegraph Company its hearty thanks for the courtesies extended by it to those astronomers who observed within the region covered by its lines the total solar eclipse of May 28, 1900.

The number of papers actually read before the Society at this meeting was approximately the same as at previous conferences, but many of these were technically presented to Section A of the A. A. A. S., and were read at joint sessions of that Section with the Astronomical and Astrophysical Society. Only those papers formally presented to the Society and of which abstracts have been submitted to the Secretary, are summarized below.

A new feature of the Society's program was the discussion of the observations made at the total solar eclipse of May 28, 1900, accompanied by the presentation of numerous photographs of the eclipse and the discussion of a program for observing the planet Eros during its close approach to the earth in the autumn and winter of 1900–'01. A summary of these discussions follows the abstracts of papers presented.

The Rate of Increase in Brightness of Three Variable Stars in the Cluster Messier 3: By S. I. Bailey.

The proportion of stars found to be variable in the cluster Messier 3, N. G. C. 5272, is greater than in any other object of the same class. This object is so low, however, at Arequipa, and the stars are so faint that satisfactory photographs of it, with the 13-inch Boyden refractor, cannot be obtained with exposures of less than 90 minutes. The rate of increase of the light of many of these stars is extremely rapid and in order to determine this change with the highest precision, photographs of very short exposure are necessary. At the request of the Director of the Harvard Observatory a series of most admirable photographs of this cluster were taken with the 3-foot Crossley reflector by Professor James E. Keeler, Director of the Lick Observatory. These photographs were taken on May 20 and 21, 1900. The first plate had an exposure of 60 minutes, but all the others 24 in number had exposure of only 10 minutes, while showing the variables at minimum magnitude. The shortness of these exposures, combined with the high quality of the plates, make the results obtained very satisfactory.

Three variable stars have already been measured on these plates. They are Nos. 11, 96 and 119. The series of plates extended from $17^h\ 42^m\ 46^s$ to $20^h\ 24^m\ 11^s$ on the night of May 20th, and from $17^h\ 2^m\ 38^s$ to $20^h\ 53^m\ 27^s$, May 21st, G. M. T. These periods of time covered the entire interval from minimum to maximum, for each of the above stars on at least one night. The same stars were also measured and 49 photographs made at Arequipa during the years 1895–1899. From a study of all these measures I find the periods to be: No. 11, $12^h\ 12^m\ 25^s$; No. 96, $12^h\ 0^m\ 15^s$; No. 119, $12^h\ 24^m\ 31^s$. For the following discussion of the rate of increase, however, only plates made by Professor Keeler, on the night of May 21st, and having exposures of 10 minutes were used.

The measures of the brightness of the

variables were made by Argelander's method, using a sequence of comparison stars whose magnitudes have not yet been determined. The results are, therefore, given in grades. The value of one of these grades is somewhat uncertain, but is not far from a tenth of a magnitude, since in a previous work the value of my grade has been 0.085 of a magnitude. The observations were then plotted, using vertical distances to represent magnitudes and horizontal distances to represent time, and a smooth curve was drawn through them. The time scale employed in this drawing was very open, in order to read with greater accuracy the ordinates of the curve corresponding to intervals of five minutes. The results of the measures are very accordant. Of all the measures on the Lick plates of ten minutes' exposure the average deviation from the curve is less than half a grade.

From these curves it appears that the total increase of light, amounting to 17.5 grades in the case of variable No. 11, takes place within 70 minutes; in the case of No. 96, an increase of 16.7 grades occurs within 60 minutes; and No. 119, 17.0 grades, within 75 minutes. The maximum increase during any interval of 5 minutes, is, in the case of No. 11, 1.9 grades; No. 96, 2.5 grades; No. 119, 1.5 grades. During 30 minutes No. 11 increases in magnitude 10.9 grades, or *at the rate* of 21.8 grades per hour; No. 96, 12.8 grades, or at the rate of 25.6 grades per hour; No. 119, 8.6 grades, or at the rate of 17.2 grades per hour. The greatest rapidity is met in the case of No. 96, where for 5 minutes the increase is at the rate of 30 grades, or about 2.5 magnitudes per hour, and during 30 minutes has a rate of 25.6 grades, or more than two magnitudes per hour. This rate of change appears to be more rapid than that of any other star known.

The Algol variable *U* Cephei, which perhaps undergoes the most rapid change of any star not found in clusters, changes at the rate of about one and a half magnitudes per hour, during the half hour when its increase and decrease are most rapid. The total times of increase of the three stars, 70, 60 and 75 minutes, are 9, 8 and 10 per cent. respectively, of their whole periods. Near the beginning and end of increase, however, the rate of change seems to be relatively much slower. If we allow one and a-half grades for each of these slow changes, making three grades in all, we find that the remaining increase, amounting to more than four-fifths of the whole change in light, takes place for the three stars in 42, 34 and 54 minutes, respectively. That is, in about 6, 5 and 8 per cent. of their respective full periods.

In the case of No. 96 this increase is about ten times as rapid as the corresponding decrease. In general it may be stated that the length of periods and form of light-curves are similar to many of those in the clusters Messier 5 and ω Centauri. (See *Astrophysical Journal*, Vol. X., 255.) It will be noted that the periods of these three stars are about one-half a day. Several other variables in this cluster appear to have approximately the same period.

The Series of Parallaxes of Large Proper Motion Stars made with the Yale Heliometer: By F. L. CHASE.

A large proper motion is, as is well known, the strongest indication of a star's nearness. Some years ago it seemed to us at the Yale Observatory that it would be a promising task to make a rather sweeping survey of all the fainter northern stars having a large proper motion to single out those which show a measurable parallax. Our list was based upon Porter's Catalogue of Proper Motion Stars, and it was our aim to take up all the stars therein contained, which showed an annual motion as great as 0''.5 excepting such as had already been observed for parallax.

It was hoped that among so large a number, nearly a hundred, some very near neighbors should be found, but in case the results should prove wholly negative it would afford some satisfaction to know that there are probably no more stars in the northern skies within a certain distance of us.

This research was begun in the summer of 1892, soon after Porter's Catalogue appeared, and has been the problem of chief attention on my part since that time. There were 86 stars in my list and 13 in Dr. Elkin's, of which I have completed the observations of 84 and Dr. Elkin 8. The original plan was to observe each star on three different nights near each of the two epochs of maximum parallactic effect. For each star when possible two suitable companion stars were chosen on opposite sides of the principal star and as nearly as possible at the same angular distance from it. The observations were made in the customary symmetrical order $S1$, $S2$, $S2$, $S1$, $S1$ denoting the angular distance from one companion star and $S2$ the distance from the other.

At first it was intended to use the known proper motions in the reductions, and it was thought that three observations at each of the two epochs would be sufficient to show any parallax as great as 0''.2, and any such cases were to be further investigated. Later it seemed to us to be desirable to eliminate the effect of proper motion independently, which can be quite thoroughly accomplished by repeating the observations through two more epochs in the reverse order, and at the same time this enlarged number of observations should furnish a pretty fair approximation to the true value of the parallax.

The plan thus modified would give us twelve complete observations for each star, which number was secured in nearly every case. Each of these complete observations furnishes an equation of condition of the form:

$$x + by + cz = n$$

where x represents the required correction to the assumed scale value, y the parallax, z the correction to the assumed annual proper motion, b the parallax factor depending upon the positions of the stars and that of the earth at the time, $c = t - 1895.0$ (1895.0 being about the middle of the period covered by the observations) and n equals the difference $S1 - S2$ minus an assumed value for this difference.

The normals from these equations of condition have all been formed and a preliminary solution has only just been finished. As to the results I may say that a little disappointment was felt that no very large parallaxes were found. However there were two stars viz: 54 Piscium and Weisse 17^h 322, which show a parallax of nearly 0''.25 and which, therefore, if the results are confirmed by further observation, will place them among the first ten or twelve nearest stars so far as at present known. I have selected for each of these stars two new pairs of comparison stars and have nearly completed a more extended series of observations of them. The final parallax will in each case depend upon 56 complete observations instead of 12 as at present.

A preliminary classification, according to the magnitude of the parallax formed, may be of some interest and is given in the following table:

Parallax.	*No. Stars.*
0''.20 to 0''.25	2
0 .15 " 0 .20	6
0 .10 " 0 .15	11
0 .05 " 0 .10	24
0 .00 " 0 .05	34
—0 .05 " 0 .00	8
—0 .10 "—0 .05	5
—0 .15 "—0 .10	2

The probable error of a single observation comes out to be on the average about $\pm 0''.170$. Taking the average weight of the parallax to be 30.0 the average probable error of the values of the parallax found would be $\pm 0''.031$. In this no account has been taken of the systematic error of the observer which has not yet been discussed for this problem. It should also be borne in mind that the parallax here found is only the relative parallax to which should be added that of the comparison stars employed.

It is our purpose further to classify the results. 1st, according to the magnitudes of the stars, and 2d according to the amount of the proper motion which may perhaps lead to interesting conclusions. The results here given may perhaps be slightly modified in the fuller discussion, but in their present form they may serve to give some idea of a piece of work, which we hope will contribute something to our present knowledge of the stellar universe.

The Velocity of Meteors as Deduced from Photographs at the Yale Observatory: By W. L. ELKIN.

The instruments in use at the Yale Observatory for the photographic observation of meteors have been equipped with an arrangement for the determination of the velocity of meteors. The idea of using photography for this purpose seems to have first been suggested as long ago as 1860 by J. Homer Lane, the well known physicist and discoverer of 'Lane's law.' In 1885 a well planned attempt in this direction was made by Zenker, in Berlin on the occasion of the expected shower of Andromedids, but apparently without success, and lately the suggestion has again been made by Professor Fitzgerald.

The Yale apparatus consists of a wheel (a bicycle wheel) rotating in front of the cameras and carrying a number of opaque screens. There are at present 12 of these interceptors and the rotation is effected at the rate of 30 to 50 turns per minute by means of a small motor worked by 3 or 4 bichromate cells. It will be advisable to increase the number of occultations in the future, however. At each revolution a record is made at the chronograph so that the wheel's velocity at any instant is always known.

The length of the interruption of a meteor trail and the resulting velocity are easily derived from the plates, if the meteor is also recorded on a plate at our second station at Hamden, distant about 3 km. The first attempt was made at the August period last year, and subsequent ones at the Leonid, Andromedid and Geminid epochs in November and December last. In all so far five such trails have been obtained with corresponding records at Hamden and the time and identification also secured. These have been carefully measured and reduced and the resulting data are brought together in the following table of which the headings explain themselves sufficiently:

Meteor No.	Date 1899	Greenwich Mean Time	Apparent Radiant 1875.0 R. A. Decl.	Appar'nt Velocity (km. per sec.)	Approximate Altitude (in km.)
		h. m. s.	° ′ ° ′		
1	July 31	17 4 30	28 55 + 57 31	50.4	88 to 75
2	Aug. 7	14 25 25	288 12 − 6 20	12.2	50 to 45
3	Aug. 8	16 32 47	43 55 + 56 33	50.3	101 to 94
4	Nov. 24	16 31 25	27 43 + 40 33	20.2	93 to 90
5	Dec. 12	21 43 0	113 44 + 33 36	36.5	90 to 86

If we now correct the values for the apparent radiant and velocity for the effect of the attraction of the earth and its diurnal rotation by Schiaparelli's formulæ, we derive the 'corrected' radiant and velocity, in the following table and hence the 'true' velocity of the meteors relative to the Sun. The last columns of this table contain the 'true' and 'apparent' velocities which a parabolic orbit, or, in the case of the November 24 meteor, an elliptic orbit of 6.62 years period should have produced.

Meteor No.	Corrected Radiant 1875.0. R. A. Decl.	Corrected Apparent Velocity. (km. per sec.).	True Velocity. (km. per sec.).	Parabolic or Elliptic Velocity (km. per sec.). True	Parabolic or Elliptic Velocity (km. per sec.). appa'nt
1	29°50′ +57°40′	49.1	34.4	41.8	58.3
2	289 44 −27 58	5.0	32.0	41.8	27.1
3	45 12 +56 35	49.0	32.4	41.8	60.3
4	23 52 +39 46	16.8	39.8	39.3	19.6
5	112 22 +33 2	34.7	34.0	42.4	49.5

A comparison of these two last columns with the corresponding ones of the observed values shows that except in the case of the Andromedid meteor on November 24th, both the apparent and true observed values of the velocity are much smaller than those derived on the assumption of a cometary velocity. The former (the observed) velocities lead to orbits of a very improbable character having periods of from 1.25 to 1.80 years, so that it would seem an almost certain conclusion that the atmospheric retardation has amounted to from 8 to 15 km. per second for the four meteors. On the other hand the Andromedid of November 24th furnishes the following orbit, by the side of which is placed that of Biela's comet according to Hubbard:

Meteor Nov. 24, 1899.		Biela Comet.	
$\pi = 108°48'$	1875.0	$\pi = 109°8'$	1852.0
$\Omega = 242\ 22$		$\Omega = 245\ 51$	
$i = 12\ 4$		$i = 12\ 33$	
$e = 0.7923$		$e = 0.7559$	
$a = 4.110$		$a = 3.526$	

Rather unfortunately this Andromedid trail is at the very edge of the plate, and therefore somewhat ill-defined, so that the length of the single interruptiou available is somewhat uncertain. If this be changed by 19″ from the original measurement, or about $\frac{1}{15}$ of a millimeter on the plate, a quantity which is, perhaps, admissible under the unfavorable circumstances, an exact agreement with the cometary elements '*a*' and '*e*' can be brought about.

This remarkable circumstance makes it, therefore, again somewhat questionable whether the small velocities found for the other four meteors may not after all be somewhere near the cosmic values and the truth will have to await accumulated evidence. Especially valuable will be a long trail with considerable change in altitude and a large number of sharp interruptions. The only one of our trails which has more than two such breaks is the one of August 7th, where three values of the velocities can be deduced. These are, in the order of the meteor's progress, and descent, 12.33, 12.11 and 12.09 km. per second, which, while showing an increased retardation, hardly admit of any definite conclusions. As I have just said, more data are necessary and we hope to secure them and also increase the accuracy in the near future.

Recent Astronomical Work at Columbia University: By HAROLD JACOBY.

Professor Rees, director of the Columbia University Observatory, being absent at Paris as a member of the international jury for instruments of precision, it devolved upon Professor Jacoby to present a very brief account of Columbia's research work in astronomy during the past year. The University possesses no adequate observatory, so that the work in observational astronomy has been perforce confined very largely to the measurement and discussion of celestial photographs. The only long series of direct observations upon the sky itself is that made during the last seven years with the zenith telescope by Professors Rees and Jacoby and Dr. Davis, who was a member of the observatory staff until last year. This series of observations was discontinued in May, 1900, because a similar one, upon a much more extensive scale, has been commenced by the International Geodetic Association. It is hoped that the Columbia observations, together with a corresponding set made at Capodimonte, Italy, will furnish a valuable contribution to our knowledge of the constant of aberration and the variations of terrestrial latitude.

The measurement and discussion of astronomical photographs has included work upon Rutherfurd negatives and upon negatives made at Helsingfors, Finland, and at the Cape of Good Hope. In connection with the Rutherfurd plates, the observatory has just published Dr. W. C. Kretz' paper on the 'Stars in the Coma Berenices Cluster.' This paper was offered by Dr. Kretz last year as his dissertation for the degree of Ph.D. It will be distributed very soon. Dr. G. N. Bauer's paper, also a dissertation for the degree of Ph.D., contains a determination of the parallax of μ Cassiopeiæ from Rutherfurd measures of position angle. It is now in course of publication, as is also a paper by Professor Jacoby on the 'Pleiades.' This latter contains the results of further computations that have been made in recent years, using the same Rutherfurd measures discussed in Professor Jacoby's former paper on the 'Pleiades,' published in 1892. The new discussions bring out the excellence of Rutherfurd's work even more clearly than before. Several other sets of Rutherfurd star plates have been measured and reduced, but it has not yet been possible to prepare the results for printing.

An attempt was made last year to photograph the November meteors, and one trail was secured by Mr. C. A. Post and Professor Rees, at the former's observatory in Bagport.

Dr. Caroline E. Furness has completed the discussion of four photographs of the stars immediately surrounding the north pole of the sky. These photographs were made at Helsingfors some years ago, and measured at the Columbia University observatory. Dr. Furness has deduced from these measures a photographic catalogue of precision including the stars within one degree of the pole, and has been able to show also that the optical distortion of the Helsingfors telescope is confined within very small limits, so far as such distortion depends on position angle. These researches are in course of publication by the observatory of Vassar College, and have formed the subject matter of a dissertation for the degree of Ph.D., conferred upon Miss Furness this year at Columbia University.

A similar series of negatives of the south pole was made some years ago at the Cape of Good Hope, and these have been in course of measurement during the past year at Columbia. It is hoped that they can be completed during the present summer, and that the results can be computed and published within a year.

The attempt to secure an independent determination of the constants of nutation and aberration by photographing close polar star trails has made considerable progress. A special 'fixed' polar telescope has now been mounted by Dr. Donner in a suitable new building at Helsingfors, at which place it is intended to make the observations, in order to take advantage of the high altitude of the pole, and the consequent diminution of atmospheric refraction. This fixed telescope will be used with the object glass of the present Helsingfors astro-photographic refractor. We shall thus secure the important adventage of using a glass whose optical distortion has been most carefully investigated. It is hoped that the actual work of making the negatives can begin at Helsingfors as soon as the nights become a little longer, and that measurements can commence at Columbia before the year is out.

Photometric Observations of the Asteroid Eros: By HENRY M. PARKHURST.

My simple formula for the diminution of the light of an asteroid in proportion to the angle at the asteroid between the sun and the earth, seems to be substantiated by Professor Müller, within ordinary limits, but the new asteroid Eros extends the angle so far as to create uncertainty. For the old asteroids the extreme value of this angle seldom exceeds 30 degrees; whereas its smallest value with Eros in the present opposition is only 28 degrees, and its greatest value more than twice that amount. In the observations of the oppositions of our moon the formula of simple proportion is appreciably changed before reaching that extent. If the formula depends upon the diminution of light in arithmetical progression, the variation is in one direction, whereas if it depends upon diminution of light measured in magnitudes, or in geometrical progression, the variation is in the opposite direction. It has seemed to me desirable that special pains should be taken to observe Eros photometrically, in order to learn what we can of the true law of diminution, and if possible its cause.

I desire especially to call attention to this desirability, for the reason that a tall building is in process of erection so close to my observatory that should it be completed early in the present year, it may prevent my photometric observation of Eros at the times essential to this investigation; in which case we must rely wholly upon such observations as may be made elsewhere. I had already made preliminary observations in anticipation of this investigation before the building was commenced; and I still hope that I may be able to complete my work before my observation of that part of the sky is cut off.

Standards for Faint Stellar Magnitudes: By E. C. Pickering.

It is believed that the following extract from the report of Professor Cross, the Chairman of the Rumford Committee of the American Academy, will be of interest to members of the Astrophysical Society.

An appropriation of five hundred ($500) dollars has been made from the Rumford Fund to be expended under the direction of Professor Pickering, for the purpose of carrying out an investigation on the brightness of faint stars by co-operation with certain observatories possessing large telescopes. This appropriation results from a communication made to the Council of the American Astronomical and Astrophysical Society held in New York last January. It was represented that the most urgent need of astronomy in America was adequate endowment of the great telescopes of the country so that they could be kept actively at work. It was shown that while the two largest telescopes of the country, and of the world, were kept constantly at work the means for the reduction and publication of the observations is wholly inadequate, while some of the largest telescopes in the country, representing a plant costing hundreds of thousands of dollars, are nearly idle and therefore useless. Observations of the greatest value can be obtained with these instruments at small expense, and it is hoped that the beginning now made will justify its permanent continuance on a large scale. The problem undertaken is the determination of the light of faint stars, selected as standards. These will furnish points of reference to which other photometric measures may be referred. Five photometers have been constructed in which by interposing a photographic wedge of shade glass, an artificial star is reduced in brightness until it appears equal to a real star, as seen in a large telescope. Thirty-six regions have been selected in different parts of the sky, in each of which a series of standards is to be measured. Five stars of about the twelfth magnitude, five of the fifteenth, five of the sixteenth, and five of the seventeenth, are to be chosen in each of these regions. The faintest stars will be selected and measured with the Yerkes 40-inch and Lick 36-inch telescope. Those of the sixteenth magnitude will be measured with the 26-inch telescope of the University of Virginia and perhaps the Princeton 23-inch telescope. The stars of the fifteenth magnitude will be measured with the 15-

inch Harvard telescope. All of these stars will be compared with the stars of the twelfth magnitude, whose absolute magnitudes will be determined with the 12-inch Harvard meridian photometer. Their relative brightness will also be determined more accurately with the Harvard 15-inch telescope. After the work is fairly started it is believed that it can be reduced to a simple routine, by which great results may be attained with a moderate expenditure. By the time this report is presented it is expected that observations with the Yerkes, Lick, University of Virginia and Harvard telescopes will be in progress.

Registration of Astronomers: By E. C. PICKERING.

A plan for the registration of astronomers desiring positions was proposed to the Society at its meeting at the Harvard Observatory in 1898. It was hoped that in this way suitable candidates could be found for vacant positions, and at the same time good positions could be found for those qualified for them. As however, the members present did not desire that the Society should undertake this work, it has been carried out by, and at the expense of, the Harvard College Observatory. Blanks of the form appended have been distributed, and during the last eight months, thirteen men and six women have applied for positions. Requests for assistants have been received from four institutions, but in only one or two cases were the vacancies filled. The number of candidates for positions is therefore abundant and it is hoped that institutions will avail themselves more freely of this register in filling positions. No charge is made either to institutions or individuals, and, if desired, communications are regarded as confidential.

GEORGE C. COMSTOCK,
Secretary.

(*To be Concluded.*)

AMERICAN MATHEMATICAL SOCIETY.

FOLLOWING its usual custom, the American Mathematical Society held its Seventh Summer Meeting in affiliation with the American Association for the Advancement of Science, at Columbia University, June 27th–29th. The Society is one of, at present, sixteen scientific bodies which have responded to the general invitation of the Association to meet simultaneously with it, their relation to the Association being described by the very flexible term 'affiliation.' These societies contribute greatly to the importance and interest of the meeting, frequently furnishing a large proportion of the total attendance and of the scientific output. In many cases a more intimate relation between them and the Association would be mutually beneficial, and plans for such a strengthening of ties are already under consideration. But, at present, the affiliated societies receive scanty official recognition. They have no representation in the councils of the Association; no official reception is given them at the meeting; they receive none of the general circulars of information issued by the Association; and the notices of the societies printed in these circulars have been, in at least one instance, unauthorized and incorrect. In short, the societies are left mostly to their own devices, and enjoy all the advantages and disadvantages of this condition.

The unusually early date of the meeting involved some conflict with the academic duties of many members, and reduced the period of preparation and accumulation of material from four to two months. But in spite of this and the uncomfortable weather, the occasion was a pronounced success. Fifty-six members of the Society were in attendance, a number which has never been exceeded. Professor Simon Newcomb, ex-President of the Society, presided at the opening of the first session, on Wednesday afternoon, and was succeeded in the chair by Vice-President E. H. Moore, relieving President R. S. Woodward, who was also President of the Association. Professor H. S. White, Professor E. W. Hyde, and the Secretary were also called to the chair during the meeting. On Thursday, the Society met, for the first time in its history, in joint session with Section A, the entire day being devoted to this combined meeting. At the morning session, at which papers chiefly from Section A were read, Professor Ormond Stone presided. On Friday, separate sessions were resumed. The final session, on Friday afternoon, was devoted to an extensive discussion, noted below.

The Council announced the election of the following persons to membership in the Society: Mr. J. L. Coolidge, Harvard University; Professor Peter Field, Carthage College; Mr. F. A. Giffin, University of Colorado; Mr. W. J. Greenstreet, Stroud, England; Mr. L. L. Locke, Fredonia, Pa.; Professor J. E. Manchester, Vincennes University; Professor W. J. Vaughn, Vanderbilt University. Six applications for membership were reported. The present membership of the Society is 342. At the meeting of the Council it was decided to set apart the life membership fund, now amounting to $600, as a special fund for the promotion of such object as the Council may hereafter designate.

The following papers were read at this meeting:

(1) Dr. A. S. Chessin: 'On the motion of a top, taking into account the rotation of the earth.'

(2) Professor F. Morley: 'On a mechanism for drawing trochoidal and allied curves.'

(3) Mr. H. W. Kuhn: 'Theorem on non-primitive groups' (preliminary communication).

(4) Dr. H. E. Timerding: 'Some remarks on tetrahedral geometry.'

(5) Professor H. B. Newson: 'On singular transformations.'

(6) Dr. Virgil Snyder: 'On a special form of annular surface.'

(7) Professor F. Morley: 'On the rational quartic curve in space.'

(8) Professor Paul Gordan: 'Die Hesse'sche und die Cayley'sche Curve.'

(9) Mr. H. E. Hawkes: 'On hyper-complex number systems.'

(10) Professor Maxime Bôcher: 'Application of a method of d'Alembert to the proof of Sturm's theorem of comparison.'

(11) Miss I. M. Schottenfels: 'On groups of order 8!/2.'

(12) Professor P. F. Smith: 'On surfaces sibi-reciprocal under those contact transformations which transform spheres into spheres.'

(13) Professor E. H. Moore: 'A simple proof of the fundamental Cauchy-Goursat theorem.'

(14) Professor W. F. Osgood: 'On the existence of the Green's function for simply connected plane regions bounded by a general Jordan curve, and for regions having a more general boundary of positive content.'

(15) Dr. J. V. Collins: 'Quaternions and spherical trigonometry.'

(16) Professor J. McMahon: 'Kelvin's treatment of instantaneous and permanent sources extended to certain cases in which a source is in motion.'

(17) Dr. F. R. Moulton: 'Oscillating satellites.'

(18) Miss B. E. Grow: 'The reduction of binary quantics to canonical forms by linear transformation.'

(19) Dr. M. B. Porter: 'Note on geometry on the non-singular cubic.'

For the Friday afternoon session, a discussion of the following question was in order:

What courses in mathematics should be offered to the student who desires to devote one-half, one third, or one-fourth of his undergraduate time to preparation for graduate work in mathematics?

The discussion was opened by the following papers:

Professor E. H. Moore: 'Certain fundamental ideas which should be emphasized throughout the undergraduate course.'

Professor J. Harkness: 'The importance of some preliminary training in applied mathematics'; 'Courses in differential calculus and differential equations.'

Professor W. F. Osgood: 'The proper time for he introduction of the lecture method'; 'Courses in differential equations'; 'Should elementary courses in more advanced subjects be included in the undergraduate curriculum?'

PROFESSOR F. MORLEY: 'Certain phases of the general question.'

PROFESSOR J. W. A. YOUNG: 'Collegiate preparation for the teaching of mathematics in secondary schools.'

A general discussion of the subject then took place.

On each evening of the meeting, the members generally took advantage of the opportunity to dine together.

The next regular meeting of the Society will be held in New York on Saturday, October 27th.

F. N. COLE,
Secretary.

THE RELATION OF BIOLOGY TO PHYSIOGRAPHY.

THE studies of paleontologists have been among our chief sources of information concerning the physiography of various regions in past geologic periods. Far-reaching conclusions have been drawn from faunal resemblances and differences as to the relations of sea and land, the presence or absence of barriers and the direction of marine currents during particular epochs of the earth's history. It is evident that biology should bear a relation to physiography analogous to that which paleontology bears to paleophysiography. Some of the ways in which the two distinct sciences react upon each other have been pointed out by Woodworth,* and it is the purpose of the writers to call attention to a specific case in point where identical conclusions were reached quite independently by different investigators pursuing distinct lines of research.

These results are of the utmost importance in the particular problems upon which they bear, but their chief value at the present time lies in the fact that they bring physiography and biology upon common ground and show that each may and should receive assistance from the other.

In discussing the origin and recent history of the physical features of the southern Appalachians* in 1894 the writers advocated the theory that the upper Tennessee River formerly flowed into the Gulf of Mexico by way of the present Coosa and Alabama rivers, and that it was diverted to its present course through the Cumberland Plateau in the latter part of Tertiary {Neocene (?)} time. The former course of this river is shown on the accompanying outline map by the dotted line *A* which extends in the direction of the upper Tennessee from the vicinity of Chattanooga southwestward to the Coosa in eastern Alabama.

This theory was again advocated by the senior author† in 1897–98, and the evidence in its support was presented in somewhat greater detail. The conclusions in both reports were based entirely upon physiographic evidence—such as the character of the Tennessee—Coosa divide, the newness of the gorge below Chattanooga and the general arrangement of the drainage lines.

We recently learned with considerable surprise and gratification that Mr. Charles T. Simpson, of the Smithsonian Institution, had independently reached the same conclusion from a study of the fresh water mollusca contained in the rivers in question.

In an equally unexpected manner Mr. Simpson has corroborated the conclusions of the junior author‡ regarding the changes which have taken place in the head branches of the Coosa, Chattahoochee, and Savannah rivers.

The conclusion that the Etowah River had been robbed by the Chattahoochee

* J. B. Woodworth, 'The Relation Between Baseleveling and Organic Evolution,' *Am. Geol.*, Vol. XIV., pp. 209–235, 1894.

* Geomorphology of the Southern Appalachians: *Nat. Geog. Mag.*, Vol. VI., pp. 63–126, May, 23, 1894.

† Physiography of the Chattanooga District. 19th Ann. Rept., U. S. Geol. Survey, Part II., pp. 1–58.

‡ Drainage Modifications and their Interpretation. *Jour. Geol.*, Vol. 4, pp. 567–581 and 657–673.

River was based upon the following facts: (1) the lowness of the divide at Dahlonega, Georgia between the Etowah River and a branch of the Chattahoochee River; (2) the similarity of the alignment of the beheaded portion with that of the remaining Etowah River, as shown at *B* on the map and (3) the plainly apparent tendency of the southeastward flowing streams to encroach upon their neighbors on the northwest in all the territory about the headwaters of the three rivers in question. This change was supposed to have taken place when the surface relief was slight, presumably on the elevation of the Tertiary peneplain above baselevel.

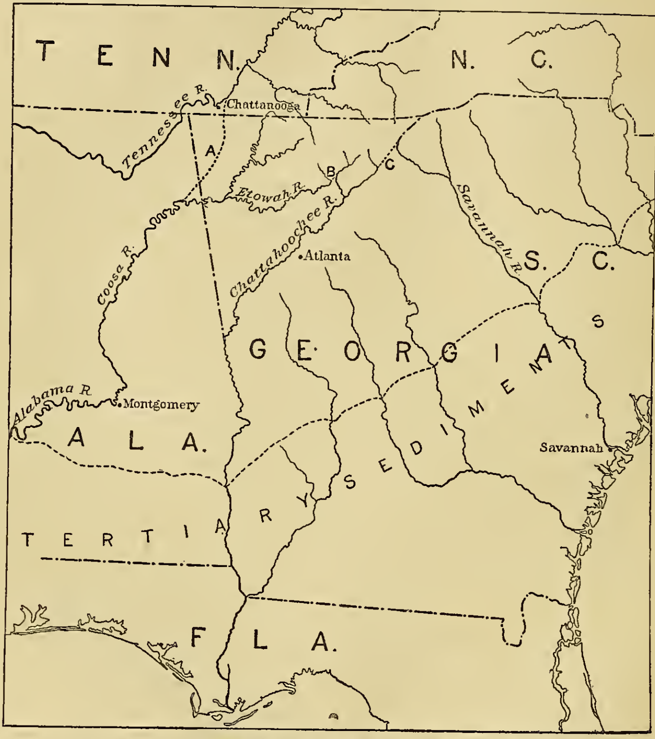


Fig. 1. Drainage map of the Southern Appalachian region, showing recent stream diversions. Hayes and Campbell.

The conclusion that the upper course of the Chattahoochee River has been transferred to the Savannah system by diversion near Tallulah Falls, at the point marked *C* on the map, was based on similar grounds, but in this case the proof is stronger for the southeastward flowing streams show even a greater tendency to encroach toward the northwest than they do in the vicinity of Dahlonega.

Thus the purely physiographic evidence shows that there was a former connection between the upper Tennessee River and the Coosa system by which the molluscan fauna could easily pass from one to the other. It also shows conclusively that a part of the Etowah River has been transferred bodily to the Chattahoochee system. Such a wholesale shifting of divides would result in the transference of such of the Coosa-Tennessee forms as then existed in the headwaters of the Etowah River.

This infusion of new forms spread throughout the Chattahoochee system, even to its headwaters, but the foreign types presumably constituted only a small proportion of the existing fauna. When the Savannah River cut through the divide and captured the upper part of the basin of the Chattahoochee, it carried with it a limited number of forms belonging to the Coosa-Tennessee type. Thus in each successive transfer the percentage of the original forms has grown less and less, until in the Savannah River, as reported by Mr. Simpson, they are scarcely recognizable.

Beyond Savannah, toward the northeast, none of the peculiar Tennessee forms have been found, nor is there any indication in the surface configuration of there having been any drainage changes of consequence in this region.

In most respects the biological evidence simply corroborates the conclusions based upon a study of the surface features, but in the question of age relations it throws some new light upon the problem. The migration of Coosa-Tennessee fauna from west to east shows conclusively that the changes in drainage must have followed a similar order, hence the diversion at Dahlonega must have preceded that which occurred near Tallulah Falls. This important fact presumably could never have been determined from the physiographic evidence alone.

Throughout the whole region there is a surprisingly close agreement between the biologic and the physiographic evidence which clearly indicates that biology should stand in the same relation to physiography that paleontology does to paleo-physiography.

The following brief statement of the evidence on which Mr. Simpson bases his conclusions was prepared at our suggestion for publication in advance of the more detailed report which the author has in preparation.

C. W. Hayes,
M. R. Campbell.
U. S. Geological Survey.

ON THE EVIDENCE OF THE UNIONIDÆ REGARDING THE FORMER COURSES OF THE TENNESSEE AND OTHER SOUTHERN RIVERS.

Several years ago while studying the life history and distribution of the Unionidæ, or Pearly Fresh Water mussels I was struck by the close relationship existing between that part of the mollusk fauna of the Tennessee River drainage system and that of the Alabama.

Within the Mississippi drainage basin there is found the richest and most wonderful, as well as the most highly developed Unione fauna of any part of the world. Perhaps not less than 400 species, at a most conservative estimate, are found in this area. The Unione fauna of the Tennessee drainage system (including that of the Cumberland) contains a very large proportion of the species found throughout the Mississippi area, and in addition to these a great many peculiar species found nowhere else in the Mississippi system. The genus *Pleurobema*, as I have defined it, a large group of forms having rather heavy, triangular shells, generally tawny colored, with broken, green rays, has its metropolis in the Tennessee area. Only three species of the genus occur in the Ohio River. Two of these Ohio River species extend west into and across the Mississippi, but I know of no form belonging to the genus that is found in any part of the lower 300 miles of that stream, in the Pearl or the Pascagoula rivers, or any of the small rivers in Mississippi or Louisiana flowing into the Gulf. No member of the genus is found in any of the streams flowing into the Atlantic (with possibly a single exception).

Yet the entire Alabama River system is filled with *Pleurobemas*. There are many of them in the Tombigbee and Black Warrior, still more in the Alabama itself, and the Coosa swarms with them. But not a species of *Pleurobema* found in the Alabama River area is identical with any found in the Tennessee system. Those of the latter drainage area are, for the most part, very closely related to each other, and belong to a single great group typified by the well known *Unio clavus* of Lamarck. There are several closely related groups of *Pleurobema* found in the Alabama system, and all these are nearly related to the *clavus* group, yet no member of the latter group is found in the southern drainage, and no member of any of the southern drainage groups is found in the northern drainage.

There are a number of Uniones which have a somewhat general distribution in the Mississippi area including the Tennessee system, that are found in the Alabama River drainage, such as the *Unio tuberculatus*, of Barnes, *U. ebenus* Lea, *U. multiplicatus* Lea, *U. cornutus* Barnes, *U. pustulosus* Lea, *U. rectus* Lamarck, *U. trigonus* Lea, and *U. obliquus* Lamarck. There are others which are only found in the Tennessee and Alabama systems such as *U. cumberlandicus* Lea, *U. conradicus* Lea, and *U. varicosus* Lea; the latter, however, extends into the Ohio River.

Yet all these which occur in the Alabama and its branches have some slight characters by which they differ from the same species when found in the Tennessee; not enough to separate them specifically or perhaps varietally from each other, yet an expert will generally be able to tell at a glance from which system a given specimen has been obtained. *Unio gibbosus* of Barnes, an abundant, widely distributed and variable Mississippi drainage species, is found in the Alabama system, but it is shorter, smaller and more humped than the type, and Dr. Lea believing it to be a valid species called it *Unio subgibbosus*. I believe that it is only a variety or geographical race of *U. gibbosus*. *Unio poulsoni* Conrad found in the Alabama River is, I am sure, only a variety of the *U. alatus* Say, a species widely distributed in the central part of the United States.

A few species of *Pleurobema*, and certain species of other genera of Unionidæ closely related to forms found in the Mississippi valley, and evidently derived from the fauna of that region are found in the Chattahoochee, the Flint River, and some of the streams of Southeastern Alabama.

In the streams draining into the Atlantic from Labrador to Georgia there is found everywhere a group of Unios typified by *Unio complanatus* Dillwyn. There are a great many forms belonging to this group which have received specific names at the hands of authors, many of which are, apparently, only mere variations of a few leading forms and not worthy of even varietal names. Quite a large number of forms belonging to this group also occur in the Chattahoochee River system, some of which appear to differ a little from the Atlantic drainage species while others do not seem to be specifically different. Many of the forms of this group in both the areas mentioned seem to be merely incipient species and the synonymy is in a hopeless tangle. *Unio columbensis* Lea, a member of the *Tetra-*

lasmus group of Unios, found abundantly in the Chattahoochee River, can hardly be separated from forms of *Unio obesus* Lea, found in the streams of the Atlantic drainage from North Carolina to Florida. Two or three members of the *Buckleyi* group of Unios seem to inhabit both the Chattahoochee River and its branches, and the Savannah River and nearby streams of the Atlantic drainage. One member of this group, *Unio tortivus* Lea, is common to certain streams flowing into the Atlantic, a considerable part of Florida, the Chattahoochee River system and the Black Warrior River, in Alabama.

These remarkable facts of Unione distribution led me long ago to believe that at a former period, during the lifetime of some of the present species of Unionidæ, sometime in the middle or later Tertiary, perhaps, the Tennessee River must have flowed southward into some one of the streams of the Alabama drainage, and through this discharged its waters into the Gulf of Mexico. It seemed most likely that this connection was by way of the Coosa on account of its nearness to Tennessee, and because the genus *Pleurobema* is more abundantly represented in that river than in the Cahawba or Black Warrior. It seemed likely, too, that during this or some nearby time there had been for a limited period connection between the waters of the Tennessee and the Chattahoochee system, either directly across to the upper part of the latter, or in some way by the Alabama system. I could account for the distribution of these forms of life in no other way, because they cannot travel overland from river to river, but must have water communication in order to pass from one stream to another.

I concluded that the connection of the Tennessee with the Alabama drainage had been severed permanently, certainly as far back as the later Tertiary. That the *Pleurobemas* being somewhat susceptible to the influence of environment had changed until new though closely allied groups had been developed in the Alabama region since the Tennessee began to flow into the Ohio; that other species of southern drainage had developed from closely allied ancestors of northern origin. Others less susceptible to environmental influence had only changed to new varieties in their new location, while still others in which the characters were firmly fixed only changed slightly in appearance.

Although it is possible that forms of the *Complanatus* and other groups of Unios might have migrated from the Atlantic along the low shores, of a former strait in upper Florida connecting that ocean with the Gulf of Mexico, and from thence up the Chattahoochee River system, yet it would seem more likely that these had passed from the Savannah to the Chattahoochee River by water connection at or near the head of these two streams which have their sources very near together.

In this brief sketch I have not gone exhaustively into the evidence presented by the Unionidæ. There are many other species found in the Alabama River system which are evidently identical or nearly related to Tennessee River forms, but which have no very close relationships with the species of any other region and which are, most likely, descendants of Tennessee forms. In fact it is probable that nearly all the Unionidæ of the Alabama River system have been derived from the Tennessee.

This subject will be discussed to some extent in my forthcoming synopsis of the Naiades.

These conclusions almost exactly coincide with those arrived at by Messrs. Hayes and Campbell, who have made a very careful and exhaustive study of the geomorphology of the Southern Appalachians. And it is indeed interesting that the geologist and biologist, though working along entirely different lines, should have met on common ground. CHAS. T. SIMPSON.

SMITHSONIAN INSTITUTION.

EDUCATION AT THE PARIS EXPOSITION.

THE general official catalogue of the Universal International Exposition of 1900 enumerates 121 classes distributed through 18 groups, of which group 1 is education and instruction comprising 6 classes, viz:

1. Education of infants, primary instruction, instruction of adults.
2. Secondary instruction.
3. Higher instruction, scientific institutions.
4. Special instruction, artistic.
5. Special instruction, agriculture.
6. Special instruction, industrial and commercial.

Thirty political divisions are represented in the exposition of class 3 and about 900 exhibits are found in the revised list. France and colonies including Algeria and Indo-China have about 500 exhibits, United States 70, Hungary 65, Mexico 42, Russia 36, Italy 21, Great Britain 20, Portugal 20, Croatia and Slavonia 17, Japan 13, Belgium 11, Roumania 10, Greece, Guatemala and Norway 4 each, Austria, Bulgaria, Sweden and Switzerland 3 each, Bosnia-Herzegovina, Equador, Holland and Servia 2 each, and one each from China, Cuba, Spain, Monaco, Republic South Africa.

The jury passing on the awards to be assigned the exhibits is threefold; first a jury of class comprising a certain number of French jurors designated by the commission and at most an equal number of foreign jurors. The class jury's organization consists of a president, vice-president (of other nation than the president), a reporter and a secretary. The president, vice-president and reporter of the class juries comprise the members of the group jury whose organization is completed by the election of a president, vice-president and secretary. Thus the jury of the first group will be composed of 18 members, 3 from each of the 6 classes.

The presidents and vice-presidents of the 18 groups will be members of the superior jury with others provided by the commissioners.

The superior jury revises the work of the group jury and determines any appeals presented to it by the lower juries. The group jury revises the work of the class jury and refers disputed questions not settled by the group to the superior jury. The class jury inspects the exhibits and assigns recompenses of five degrees, viz:

1. Grand Prix, the highest.
2. Diplomes, etc., Medaille d'or.
3. " " d'argent.
4. " " d'bronze.
5. " " mention honorable.

On the completion of the work of inspection the class jury presents two lists: (1) a list of exhibits not competing by reason of the exhibitor being a member of a jury, or from other cause; (2) a list of the awards in alphabetic order, each diploma grouped by itself irrespective of country; *e. g.*, all the grand prizes, the gold medals, etc.

The jury of class 3, higher instruction and scientific institutions, completed its work on time, *i. e.*, on or before June 30, 1900. To the 900 exhibits it assigned 64 grand prizes, 92 gold and 105 silver. The bronze and honorable mentions were naturally more numerous and all may be changed slightly by revision. 27 grand prizes were given to French exhibits, 9 to United States, 5 to Great Britain, 3 each to Hungary, Japan and Russia, 2 each to Belgium, Mexico, Roumania, Italy, and 1 each to Austria, Canada, Croatia, Portugal, Norway and Sweden; total 64.

France received 44 gold prizes, United States 9, Russia 8, Hungary 6, Great Britain 5, Mexico 3, seven others 2, and three others 1; total 92.

As the awards to the United States were in several instances collective, *i. e.*, one prize assigned to two or more exhibits, each to receive the diploma if desired, the following detailed statement is given. The awards are grouped in order of merit, beginning with the highest, the grand prizes. The numbers prefixed are those of the official catalogue, and collective awards are connected by braces. In three instances on the personal motion of a French juror distinguished merit was recognized in individuals, viz, Professor H. A. Rowland, Johns Hopkins University; Professor Nicholas Murray Butler, Columbia University; Director Melvil Dewey, University of the State of New York.

AWARDS TO THE UNITED STATES.

GRAND PRIZES.

43. The section in its exhibits of superior instruction and scientific institutions.

37. 59. 69. } University of the State of New York. {
- Museum. Paleontological reports.
- Library. Travelling libraries, home education.
- College. Professional education in the United States.

7. Congressional Library, Washington. Photographs and publications.

38. 52. } Harvard. {
- University. Publications, models, etc.
- Observatory. Photographs, Observations, etc.

63. University of Pennsylvania. Archæologic expeditions.

53. Johns Hopkins University. Spectra, publications, etc.

Collaborator, Professor H. A. Rowland. Diffraction gratings, etc.

54. American library association. Publications, materials and method.

Collaborator, Melvil Dewey, Librarian and educator.

GOLD MEDALS.

22. Denton Brothers. Collection and preservation of butterflies.

50. 28. } Columbia. {
- University. Photographs, publications, Psychology.
- Teachers college. Higher normal school.

32. Massachusett Institute of Technology. Programs and works.

49. University of Chicago. New Departure of continuous sessions.

51. Cornell university. Section civil engineering.

5. 11. 18. 19. {
- Alumni association of colleges for women. Higher instruction of women.
- Illustrative. { Bryn Mawr. Vassar. Wellesley.

29. Educational Review, Dr. Nicholas Murray Butler, Editor.

47. University of California. Plans and prospects.

64. Princeton University. Photographs and publications.

65. Yale University. Sheffield Scientific School.

SILVER MEDALS.

1. American Book Company. Publications in higher education.

2. 8. 9. 35. 39. 40. 67. } Monographs on higher instruction in the United States. {
- H. B. Adams. Vacation schools and university extension.
- M. Carey Thomas. Education of women.
- J. McK. Cattell. Scientific associations.
- T. C. Mendenhall. Scientific, technical and engineering instruction.
- James Russell Parsons, Jr. Professional education.
- E. D. Perry. The American university.
- A. F. West. The American college.

10. Cercle Français of Harvard and other universities.

62. New York University. School of Pedagogy.

30. Foote mineral company. Collections of minerals for colleges.

BRONZE MEDALS.

31. Hemment. Photographs of games and sports in American colleges.

45. Silver, Burdett & Co. Publications in higher instruction.

46. Dana Society of Natural History, Albany, N. Y. Publications.

HONORABLE MENTION.

59. University of the State of New York.

Collective exhibit of {
- Chautauqua University,
- Brooklyn Institute,
- Pratt Institute,
- Peoples Institute,
- Rochester Atheneum.

Grand prizes 12, gold 14, silver 11, bronze 3, mention 5, total 45.

HENRY L. TAYLOR, PH.D.
Rapporteur class 3.

UNIVERSAL INTERNATIONAL EXPOSITION OF 1900
UNITED STATES PAVILION, PARIS.

EIGHTEENTH ANNUAL REPORT OF THE COMMITTEE ON INDEXING CHEMICAL LITERATURE.

The Committee on Indexing Chemical Literature respectfully presents to the Chemical Section its Eighteenth Annual Report, covering the nine months ending June 1, 1900.

WORKS PUBLISHED.

Index to the Literature of Zirconium. By A. C. Langmuir and Charles Baskerville. Smithsonian Institution, Washington City, 1899. 29 pp. 8vo.

This forms No. 1173 of the Smithsonian Miscellaneous Collections. The chronological list of references is followed by a Matter-Index.

A Bibliography of Steel-Works Analysis. By Harry Brearley. *Chem. News*, 80, 233, *et seq.* (Nov., 1899).

The partial bibliography is confined to the contents of three English journals: *Chem. News*, *J. Chem. Soc.* (London), and *J. Iron and Steel Inst.*

The Committee also reports the publication of two foreign bibliographies:

Führer durch die gesammte Calcium-Carbid und Acetylen-Litteratur. Bibliographie der auf diesen Gebieten bisher erschienenen Bücher, Journale, Aufsätze in Zeitschriften, Abhandlungen und wichtigeren Patentschriften. Herausgegeben unter Mitwirkung von L. Ludwig. Berlin, 1899. 8vo.

This covers the industrial field as fully as the bibliography by Matthews (Smithsonian Miscellaneous Collections) does the scientific field, and both taken together are important for students of the subjects.

Répertoire générale, ou Dictionnaire méthodique de bibliographie des industries tinctoriales et des industries annexes depuis les origines jusqu' à la fin de l'année 1896. Par Jules Garçon. Paris, 1899–1900.

The first volume of this extensive work contains a chapter on the sources of chemical bibliography, in which the author fully recognizes the works issued under the auspices of this committee and those published by the Smithsonian Institution. The author writes: "America yields to no nation in the matter of bibliography; an American devised the decimal system of bibliography, and Americans framed the Committee on Indexing Chemical Literature, of which the Reports, edited by Mr. H. C. Bolton, are found in the Proceedings of the American Association for the Advancement of Science, since 1883."

REPORTS OF PROGRESS.

Dr. Alfred Tuckerman has completed and sent to the Smithsonian Institution a Supplement to his *Index to the Literature of the Spectroscope*, which covers the period from 1887 to 1899.

Dr. H. Carrington Bolton's *Second Supplement* to his *Select Bibliography of Chemistry*, containing a list of 7500 chemical dissertations is passing through the press; it will form a volume of the Smithsonian Miscellaneous Collections.

Mr. A. G. Smith, of Cornell University, is engaged on an *Index to the Literature of Selenium and Tellurium*, which, it is expected, will be completed this summer.

Dr. Frank I. Shepherd, Secretary of the Cincinnati Section of the American Chemical Society, plans a bibliography of the *Alkaloids*.

Mr. Frank R. Fraprie, of the University of Illinois, Urbana, Ill., writes to the Committee that he contemplates preparing an *Index to the Literature of Lithium.*

The Committee chronicles the new method of indexing chemical substances used by M. M. Richter in his *Lexicon*, and by the editors of the *Berichte der deutschen chemischen Gesellschaft*, in which the references to organic compounds are arranged under their empirical formulæ; the Chairman of your Committee finds that Mr. Edwin A. Hill, of the U. S. Patent Office, has been engaged for more than two years in cataloguing chemical bodies under their empirical formulæ for convenience of his office. Mr. Hill's system is adaptable to inorganic compounds as well as to those of carbon, and differs from the German plan in the arrangement of the symbols, being much simpler. The method will be explained in print before long.

It is gratifying to note the increasing and continued interest in bibliography on all sides, and the Committee stands ready to encourage the movement in chemistry by practical assistance to those desirous of contributing to the now considerable list of indexes. Address correspondence to the Chairman, at the Cosmos Club, Washington, D. C.

Committee:

H. CARRINGTON BOLTON, Chairman.
F. W. CLARKE (in Europe),
A. R. LEEDS,
A. B. PRESCOTT,
ALFRED TUCKERMAN,
H. W. WILEY.

SCIENTIFIC BOOKS.

A Text-book of Physics. By W. WATSON, A.R.C.S., B.Sc. (London), Assistant Professor of Physics at the Royal College of Science, London. London, Longmans Green & Co.; New York, The Macmillan Company, 66 Fifth Avenue. Price, $3.00.

This book deserves the careful attention of those teachers who are allowed with their students sufficient time to develop an elaborate course in general physics. It will be especially suited to their needs if their students are able to take an interest in the more abstract parts of the science. For those who are limited in time, or who are not in position to do rather advanced work, it will not be so useful. The book is almost as long as Atkinson's 'Ganot,' and contains a much larger amount of matter that requires thought and study than that well-known work. In order to condense it as much as possible the author has excluded elaborate illustrations and descriptions of apparatus. The space thus gained is used for the discussion of elementary points of theory or for the mention of modern theories and results. The book is consequently not one which can be read hastily or with large omissions, and to go through it thoroughly with a class will require at least four hours a week for a year. As a book of reference, both for students and teachers, it will be found to be of considerable value.

The order in which the various subjects should be presented which are comprised under the general title of physics has always offered difficulties to the writers of text-books. Mr. Watson has used an order which to some extent is new, and which is designed to avoid anticipating principles or theorems which have not been established. He has succeeded perhaps as well as anyone can in an effort in which complete success is impossible. The principal features of his arrangement, which are not of the conventional form, are: the development of the kinetic theory of gases under the head of Properties of Matter, before the subject of Heat has been introduced; the treatment of wave motion on the surface of liquids in immediate anticipation of the subject of Sound, the subject of Wave Motion and Sound following Heat instead of preceding it in immediate dependence on Mechanics; the division of the Electromagnetic Relations of the Electric Current into two parts, separated by a considerable interval; and a similar division of Magnetism by the omission of Magnetic Induction from the chapters where it usually is given and its insertion later, just before the presentation of Electromagnetic Induction.

The most serious defect in the book is the inadequate treatment of the subjects of moment of force and of the properties of the center of mass. Judging from what the author says in connection with his description of the properties of the physical pendulum, his treatment of these subjects and of others allied to them was determined because of the mathematics involved in a fuller presentation. It has, however, been demonstrated by experience that a method such as that used in Selby's 'Mechanics' furnishes a satisfactory foundation for the study of moments of force and of the uniplanar motion of rigid bodies, and that this method is easily comprehended by students. The mathematics involved in it are no more difficult than those used throughout this book.

We have noticed a few errors of statement, some of which may be mentioned, as they would embarrass a student. Thus (p. 27) the measurement of a velocity does *not* require the determination of the change in the direction of motion; the discussion of Avogadro's law (p. 171) contains a deduction of the Maxwell-Boltzmann theorem which is certainly illogical, the deduction being based on the constant relation between the temperature and the kinetic energy of the molecules of all gases which was established by that theorem; electricity is *not* energy (p. 673), although its manifestation requires the expenditure of energy; electromotive force is *not* equivalent to difference of potential (p. 674), the former term including cases which cannot be described in terms of the latter; the formula for the velocity of electric waves is given incorrectly on p. 858, and the mistake is repeated on p. 861, where Maxwell's relation between the index of refraction and the specific inductive capacity is deduced from it by a series of algebraic errors.

One other matter needs to be noticed more particularly. In the section on the Liquefaction of Gases (p. 286), after giving an account of the method of Wroblewski, so efficiently employed by Olszewski, the author describes Dewar's method, attributing its operation to the principle that when a gas expands against pressure it does work and hence becomes cooled. This principle was the one employed by Cailletet and by Pictet in their successful attempts to liquefy gases. In their experiments the liquid product was obtained in the tube in which the gas was compressed, the gas emitted when the stopcock was opened acting as a piston pushed out by the pressure of the gas left in the tube, and the cooling effect was, at least partially, due to the work done by this remaining gas and was experienced by it. When we examine the description of the Dewar method it appears that the expansion is so gradual that it cannot be considered even approximately adiabatic and that the gas which is cooled is that which has passed out of the chamber in which it is compressed. A comparison of this description with that of the Linde method (p. 320), shows that the methods are alike in every essential particular, including the important feature of 'the regenerative process,' and that the principle which applies to both of them is that which is so well explained by the author on page 318. Surely it cannot be contended that different principles apply in the two cases because in the Dewar method the gas to be cooled is contained in a vessel in which the pressure gradually falls, while in the Linde method the supply of gas is renewed by a pump so that the pressure is kept approximately constant. In view of the claims made by Linde (*Wied. Ann.* 57, p. 332), which have never been successfully controverted, such an account of the Dewar method should never have been given, or if given it should have been accompanied with some adequate justification for it. It is incumbent on the writer of a text-book to be unusually careful in making statements on disputed points, and particularly on questions of priority, since his opinions are naturally adopted by his readers as those of an impartial umpire.

The book is well printed, its diagrams and illustrations are excellent, and it contains much new matter, and old matter put in a new way. It deserves to take a high place among the text-books of physics.

W. F. Magie.

Princeton University.

ORNITHOLOGY.

In 'The Birds of Rhode Island' by Howe and Sturtevant, we have a very acceptable addition to the excellent lists already published of the birds of several of the States. Lists of this character are useful in bringing together the scattered notes pertaining to a given region, thereby saving the reader the time and trouble of hunting through many volumes. The authors have arranged their book in two parts: The first reviews the former publications on the birds of Rhode Island as well as the State collections, gives some details on migration, and a full account of the historic 'Cormorant Rock'; the second part includes an annotated list of three hundred and three species, and a bibliography of one hundred and eighty-five titles. Of the three hundred and three birds accredited to the State, two hundred and ninety are based on positive records, three have been exterminated through the agency of man, and ten are placed in a hypothetical list as the evidence of their occurrence is not absolutely conclusive.

The most valuable matter to one interested in distribution is the list of one hundred and eleven breeding birds, which concludes the chapter on migration. The work, which was published privately, contains a little over one hundred pages, and is illustrated by six fairly good half-tone plates, representing nests or nesting sites. The text is good and we are glad to recommend the book to the consideration of the public.

A. K. F.

D. LANGE's little book, 'Our Native Birds and how to protect them and attract them to our homes'* is one of the many popular treatises issued for the commendable purpose of awakening public interest in the protection of birds. To make the matter more available and easy of reference the various subjects are treated in eight sections, some of which are further subdivided into chapters. Among the causes of the decrease of song birds given by the author are lack of proper nesting places, lack of water, the English sparrow, boys, collectors, birds on hats, and the cat (which, in the opinion of the reviewer, destroys more bird life than all the others combined). For the purpose of protecting the birds and encouraging them to come to the door yards he advocates planting trees, shrubs and vines for them to live in, putting up nesting boxes for breeding purposes, providing an abundance of water for drinking and bathing, and regular feeding in winter and during unfavorable weather generally.

He very properly deprecates the killing of predaceous mammals and advocates protection for the birds of prey. We rather wish the chapter on 'Birds before Uncle Sam' had been omitted, but the book as a whole is well got up and should be read by all bird lovers.

A. K. F.

* Macmillan Co., 66 Fifth avenue, New York City. Price, $1.00.

BOOKS RECEIVED.

A Treatise on the Theory of Screws. ROBERT STAWELL BALL. Cambridge, The University Press; New York, The Macmillan Company, 1900. Pp. xix + 544. 18s.

The Contents of the Fifth and Sixth Books of Euclid Arranged and Explained. M. J. M. HILL, Cambridge, The University Press; New York, The Macmillan Company, 1900. Pp. xii + 143.

Aberration and the Electromagnetic Field. GILBERT T. WALKER, Cambridge, The University Press; New York, The Macmillan Company, 1900. Pp. xix + 96. 5s.

Exploitation commerciale des forêts. M. H. VANULBERGHE. Paris, Gauthier-Villars, 1900. Pp. 155.

Les Phénomènes de Dissolution et leurs Application. V. THOMAS. Paris, Ganthier-Villars, 1900. Pp. 196.

Tonometrie. F. M. RAOULT. Paris, G. Carré and C. Naud, 1900. Pp. 116.

L'Élimination. H. LORENT. Paris, G. Carré and C. Nand, 1900. Pp. 75.

An Outline of the Theory of Thermodynamics. EDGAR BUCKINGHAM. New York and London, The Macmillan Company, 1900. Pp xix + 205. $1.90.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology for May–June, 1900, opens with an article on 'Methods of Studying Earthquakes,' by Charles Davison. Three methods of determining the epicenter are discussed, depending respectively on the direction of the force, the time of occurrence at successive points, and the intensity of the shock. Double-shock earthquakes are put into two classes: those in which two successive shocks, separated by an interval of fifteen seconds or more, proceed from a single epicenter; and 'twin earthquakes,' having two foci whose impulses are due to the same initial stress. In these the interval between the two shocks varies from zero to a few seconds. E. R. Barbour describes 'Glacial Grooves and Striæ in Nebraska,' giving the geographical distribution of glaciation and the direction of the striæ. Charles E. Monroe notes a 'New Area of Devonian Rocks in Wisconsin.' The area is a small one near the northern boundary of Ozaukee county in the vicinity of the village of Lake Church. He gives a list of Devonian fossils from this outcrop. C. R. Keyes contributes an article on 'Kinderhook Stratigraphy.' The data of recent deep well drillings along the Mississippi River are brought to bear upon the perplexing question of the correlation of the Kinderhook beds at Burlington, Ia., with those of Illinois and Missouri. In a paper on the 'Probable occurrence of a larger area of Nepheline-bearing rocks on the northeast coast of Lake Superior,' Frank D. Adams describes thin sections of rocks from a magma rich in alkalis, and closely related to the nepheline-syenites. Hans Rusch discusses 'The Last Stage of the Ice Age in Central Scandinavia.' He offers a new theory of the origin of the glacial lakes north of Christiana, whose beaches occur in the upper parts of the valleys to the south of the divide. In an extended article Buckley continues his valuable discussion of the 'Properties of Building Stones' which was begun in the number for February–March, 1900. Editorial, Reviews, and a list of Recent Publications close this valuable number with its varied table of contents.

J. H. S.

Terrestrial Magnetism and Atmospheric Electricity for June contains the following articles:

'The Magnetic Observatory at De Bilt, near Utrecht,' M. Snellen; 'Magnetic Intensity Variometers,' M. Eschenhagen; 'Einige Bemerkungen zur Messung der Horizontal-intensität des Erdmagnetismus Mittels des magnetischen Theodoliten,' J. Liznar; 'A Possible Cause of the Earth's Magnetism and a Theory of its Variations,' William Sutherland; 'Biographical Sketch of Dr. William Gilbert' (with portrait); 'Some recent Contributions to Terrestrial Magnetism,' L. A. Bauer.

SOCIETIES AND ACADEMIES.

THE TEXAS ACADEMY OF SCIENCE.

The Annual Meeting of the Texas Academy of Science was held in the Chemical Lecture Room of the University of Texas on the morning of June 18, 1900, President Simonds in the chair.

The program offered was as follows:

1. 'The Nature of Justice,' by Professor S. E. Mezes, University of Texas.
2. 'The Development of the Present Texas Railway System,' by R. A. Thompson, M.A., Engineer to the State Railroad Commission, Austin.
3. 'Mind and Brain,' by Dr. Edmund Montgomery, Hemstead, Texas.
4. 'The Relation of the Work of the Sanitary Engineer to the Public Health,' by J. C. Nagle, M.C.E., A. and M., College of Texas.

The following papers were read by title:

1. 'Note on the Marte and Bluff Meteorites,' by Professor O. C. Charlton, Baylor University, Waco.
2. 'My Experience with a Siphon Pipe-Line,' by John K. Prather, B.S., Waco.
3. 'Fossils of the Fort Worth Limestone near Waco,' by John K. Prather, B.S., Waco.
4. 'Research Work done in Organic Chemistry at the University of Texas,' by J. R. Bailey, Ph.D., and Messrs. S. F. Acree, M.S., Louis Knox, Louis Kirk, and Omerod Palm.

In his paper on the 'Nature of Justice,' Dr. Mezes undertook to base the conception of justice on the systems of legal justice of the most advanced nations, in so far as these systems are in agreement; the ground for this position being that the conclusions are thus made to rest on a study of the best instances of justice that can be investigated. It was pointed out that there are three subdivisions to justice. The first subdivision defines and forbids the doing of wrong, either to private individuals or to the public; the legal basis here is the law of torts and the criminal law. The second defining the benefits that each individual receives from others and from society, points out those to whom return should be made for these benefits, and requires that such return be made; here the legal basis is the law of contract, and the little systematized law of the obligations that arise out of relations. The third subdivision deals with the proper procedure towards those charged with injustice, and the just treatment of the unjust, but how should they be treated and who should take them in hand; here the basis is the law of procedure, and portions of the law under the heads previously mentioned. Otherwise stated, under the first head the line is drawn separating liberty from license; under the second specification is made of the individual's debts and of the payment that honesty demands; under the third provision is made for readjusting the balance that injustice has disturbed. In conclusion the speaker pointed out that justice requires each man to consider his capacities, the deserts of others, their needs, and all the other relationships in which he finds himself, and then to do his part as the particular social member that he is.

Mr. Thompson discussed the development of the present railway system of Texas and illustrated by map and diagram the progress of construction from the inception of the first line to the present time. The first railway charter was granted in 1836. The first road to begin construction was the Buffalo Bayou, Brazos and

Colorado R. R. in 1852 near Harrisburg. It is now known as the Galveston, Harrisburg and San Antonio Railway. Construction on the Houston and Texas Central R. R. began in 1853; on the Galveston, Houston and Henderson in 1854; and on the Texas and Pacific in 1856. By 1860, 284 miles of railway were in operation in Texas; by 1870, 583 miles; by 1880, 2581 miles; by 1890, 8486 miles; and by 1900, 9869 miles. Texas has donated to the railways of the State 34,179,055 acres of public land, or 53,405 square miles, or one-fifth of its total area. This territory would form a State as large as Arkansas.

Of the States of the Union Texas is third in railway mileage. Were it as well developed in proportion to area as Illinois it would have 50,759 miles; if as well as Pennsylvania, it would have 57,900 miles of railway.

The effect upon the mileage of the State resulting from the donation of land to the railways was also shown.

Professor Nagle's paper dealt with a few of the more important questions which present themselves to the sanitary engineer and their relation to public health. Statistics regarding the death rate from preventable diseases were given, special attention being devoted to typhoid epidemics as affected by impure water supplies. Methods of water purification were described and their relative values discussed and the necessity of preventing water waste emphasized. Methods of sewage treatment and garbage disposal were similarly treated, and figures given to show the degree of purification attainable.

It was pointed out that during the past fifty years the medium age of man has been increased about 25 per cent. and this was attributed to the marvelous discoveries in bacteriology. That the sanitary engineer has provided means to greatly diminish the death rate due to bacteriological diseases there can be no question. The remarkable vitality of certain forms of bacterial life under what appear to be unfavorable conditions was illustrated by reference to actual examples as were also the effects attained by changes in water supplies and the treatment of sewage.

The speaker took the position that the engineer should not only execute such works as may be entrusted to him but should endeaver in every legitimate way to mould public opinion in such matters, and furthermore, that when the fact is recognized that the assistance of the engineer is often-times as necessary as that of the physician, then will a more sanitary condition exist, especially in the cities and towns of the south and west.

The following officers were elected for the ensuing year: President of the Academy, Henry Winston Harper, M.D., F.C.S., Professor of Chemistry in the University of Texas; Vice-President, O. C. Charlton, Professor of Science in Baylor University, Waco; Secretary, Frederic W. Simonds, Ph.D., Professor of Geology in the University of Texas; Treasurer, R. A. Thompson, M.A., C.E., Engineer to the Texas Railroad Commission, Austin; Librarian, Wm. L. Bray, Ph.D., Professor of Botany in the University of Texas; other Members of the Council: H. L. Hilgartner, M.D., Austin; J. C. Nagle, M.A., M.C.E., Professor of Engineering in the Agricultural and Mechanical College of Texas, and T. U. Taylor, M.C.E., Professor of Applied Mathematics in the University of Texas.

F. W. S.

DISCUSSION AND CORRESPONDENCE.

EPITROPISM, APOTROPISM AND THE TROPAXIS.

IN an article published in SCIENCE for July 13, 1900, entitled 'The Structure and Signification of Certain Botanical Terms,' I mentioned epitropism, apotropism and tropaxis as among terms of that kind which I had long personally used but never before published. The following notes illustrate the manner in which I originally used them in my college lectures and, in rewriting them, I have found it convenient to retain in part their original didactic style. It is not my present purpose to compare my method of treating this subject with the methods of other writers, and I shall therefore not refer to them.

The archetype, or elemental form, of every highly organized plant, especially every phenogam, is a simple erect shaft, which becomes the main shaft of the mature plant. As the main shaft increases in growth from the plantlet secondary shafts spring from it, those from the upper portion becoming branches and those from the lower portion becoming roots. The primary or main shaft has two axes, a longitudinal and a transverse. In endogenous plants the longitudinal axis, although always existent, is seldom visually well defined. In the woody exogens, however, its position is clearly marked by the central pith. The transverse axis is visually inconspicuous in all plants but no structural or functional portion has a more real existence than has this axis. Its location is in a discoid portion of the main shaft, and from it the upward and downward growth-forces diverge, or turn in opposite directions. I have therefore called it the tropaxis. The condition, or manifestation of growth-force, which is normally exhibited by the part of the plant above the tropaxis I have called apotropism, and that exhibited by the part below the tropaxis, epitropism, as explained in the former article. Therefore while growth of the respective parts is, in a general way, toward and from the earth it may more distinctively be said to proceed in opposite directions from the tropaxis.

Epitropism and apotropism reside potentially in the individual cells of the growing parts of the plant. Each condition is normal in its own division and in the ordinary growth of the plant each is stable as a physiological balance to the other. Both epitropism and apotropism are, however, less stable in some plants than in others, in which cases the normal condition is, at certain points, exchanged for the opposite condition. That is, under circumstances presently to be mentioned, cells that are normally apotropic change to an epitropic condition, when secondary roots or aërial rootlets result; and under other circumstances epitropic cells undergo the reverse change, when suckers or new plants result. Again, there is a kind of both epitropism and apotropism due to special physiological causes. Therefore there are not less than three kinds or grades of epitropism and apotropism.

The normal apotropic condition of that part of the plant which is above the tropaxis may be called primary apotropism. It is that manifestation of growth-force which is concerned in giving form and character to all that part of the plant above ground. Secondary apotropism is that condition which results in the change of small clusters of cambium cells at certain points upon the roots of a plant from their normal epitropic to a complete apotropic condition. It is this change which results in the production of suckers or new plants. Secondary apotropism is sometimes spontaneous and sometimes due to exciting causes, among which is the infliction of wounds. Spontaneous results are seen in the abundant suckers which rise from the roots of the Silver-leaf poplar, and those caused by wounds are seen in the suckers which freely rise from the spade-wounded roots of the garden cherry tree. Another interesting example of secondary apotropism, which is accompanied by secondary epitropism, is seen in the method of propagating willows and cottonwood trees which is sometimes practiced on our prairie soils. Poles are cut down, trimmed, notched at intervals with the ax, and buried in furrows of moist earth. Clusters of primary apotropic cambium cells adjacent to those wounded by the ax take on secondary apotropic action and suckers result, which are well nourished in their early stage from the poles. Special apotropism will be presently mentioned.

The three grades or kinds of epitropism proper, are primary, secondary and special, all of which are distinct from the ordinary epitropism of gravitation. The latter is plainly mechanical and is conspicuously observable in the drooping of branches and in the downward curving of the stems of heavy fruits. Primary epitropism is confined to that part of the plant below the tropaxis where it is a balancing, but in some sense an opposing force to primary apotropism. It is secondary epitropism which is manifested in the production of secondary roots and aërial rootlets. It may be spontaneous, when it constitutes one of the acquired habits of the plant in which it occurs, or it may be due to accidental circumstances. In each case clusters of apotropic cambium cells take on epitropic action and form, not adventitious buds, as is the normal habit of such cells, but aërial rootlets or true roots. The aërial rootlets of the ivy and the frequent rooting of creeping plants are familiar examples of spontaneous secondary epitropism, and the ready rooting of cuttings of the grape and the common currant are equally familiar examples of secondary epitropism resulting from wounds and contact with moist earth. The Banyan tree presents a remarkable case of spontaneous secondary epitropism. Pseudo-branches of this strange tree, or branches which seem to have become epitropically surcharged, begin a rapid growth toward the earth, perhaps aided by gravitation. When the distal end has reached the earth true roots spring from it and penetrate the soil, and a new tropaxis is formed immediately above them. Above the tropaxis the shaft assumes a fully apotropic condition and sends forth branches some of which repeat the process described until the added shafts form a vitally united grove.

The tropic balance is so stable in some plants, the oaks and walnuts for example, that it is difficult if not impossible to produce in them either secondary epitropism or secondary apotropism. Therefore, the forester propagates these trees only from the seed. In other plants, however, the tropic balance is so unstable that propagation is readily accomplished by cuttings and layers, success in these cases being due to secondary epitropism. In the case of cuttings the fragments of apotropic branches which are used for the purpose become the main stems of the new plants, a new tropaxis forming in each just above the end which is inserted into the moist earth, and whence the new roots spring. It is an interesting fact, as illustrated by the grapevine and the common currant bush that those plants which most fully and readily manifest secondary epitropism as a consequence of wounds seldom manifest it spontaneously. So persistent are cuttings of the currant bush, for example, in producing roots when inserted into moderately warm, moist earth, that they do so even when otherwise subjected to wanton violence. As a result of one of my experiments when the distal or upper end of the cutting, instead of its proximal or lower end was inserted into the soil, roots and a new tropaxis were produced there as they were at the proximal end of those which were not reversed; and branches sprang from the axillary buds, as they did in the other cases.

Examples of special epitropism and apotropism are seen in the epitropic curve of the peduncle of nodding flowers and the subsequent erection of some of them with the seed-laden ovary against gravitation, under the influence of fertilization of the ovules. The Western Primrose, *Dodecatheon medea* is a good example of this kind. Special epitropism alone, under the same influence, is seen in the laying of its fertilized ovary upon the grouud by *Cyclamen Europœum*, and in the thrusting of its fertilized ovary beneath the soil by the common peanut plant.

As a rule, the growing parts of every plant, except its tropaxis, is under the influence of either epitropism or apotropism, but other parts of some plants are also neutral or atropic. This condition exists in the slender organs called runners such, for example, as those of the strawberry above ground and the so-called stems of the potato under ground. The strawberry runner begins its growth just above the tropaxis, assumes a horizontal position, increases only at the terminal point and shows no tendency to differentiate in form or either to rise or enter the soil until it has reached considerable length. Then suddenly both epitropic and apotropic action takes place in the terminal cells which results in a new and perfect plant, rooted in the soil and becoming wholly independent by the withering of the runner from which it sprang. The function of the runner was that of a temporary vehicle for the dispersion of the species and purveyor of primary subsistence for the new plant. Among the ordinary roots of the potato plant atropic underground runners are produced at the distal end of each of which the potato, a tuberous branch having embryonic buds, is formed. In these buds apotropism is potentially developed but temporarily suspended. The function of these runners is that of one method of propagating the species and the storing of subsistence for the future plants.

It need not be mentioned that the foregoing condensed notes contain the statement of no new fact or principle, but I am confident from my former use of this method of presenting the subject that they possess some educational value. I also claim that the special terms I use are more expressive and convenient than are some others which are used with reference to the same subject.

CHARLES A. WHITE.
SMITHSONIAN INSTITUTION,
July 12, 1900.

INITIATION OF NEW ELEMENTS IN FOSSIL FAUNAS.

THE constantly growing refinement in investigative method that is demanded by every branch of geological science has caused even the most familiar phenomena to be examined from new view-points. In no department of geology has this change of position been more marked than in paleontology. In problems of geological correlation and comparative chronology the individual species of fossils have come to be considered more from the standpoint of dependent components of complex faunas than as mere isolated accidental factors.

With this closer study of organic remains and in their consideration broadly as distinctive assemblages or faunas, there has arisen a tendency on the part of paleontologists to give new meanings to old conceptions. Conspicuous among examples of this sort is a decided proneness to push backward the geological time divisions.

As an illustration, the appearance of an Ordovician type among fossils occurring in recognized Cambrian is pointed out as profoundly significant. The occurrence of several such younger factors among older ones has given grounds for proposing to lower the basal line of the newer terrane notwithstanding the great preponderance of the older forms of life.

The initial appearance of younger or newer faunal elements is no doubt highly significant, but it can hardly have the transcendent importance often ascribed to it. The importance of all such events is fully recognized. When, however, it comes to making one or a few factors of this kind overbalance predominating older elements some caution is necessary.

We can hardly consider a new faunal age to begin with every initial introduction of a new faunal element. Faunas have their beginnings far down in depths of older faunas. They expand, displace the older elements and culminate. They decline and fade away far up among still newer faunas. We have analogous examples in the progress of nations. The initiation of a new element does not indicate a new dynasty. A new political movement has its birth amid a multitude of conflicting elements. It may grow in importance and finally displace the existing government. Only when it has overcome the older, ruling powers is a new régime inaugurated. Not until then does the nation acquire a new name. There are long steps between the initiation of a new element and the initiation of a new régime.

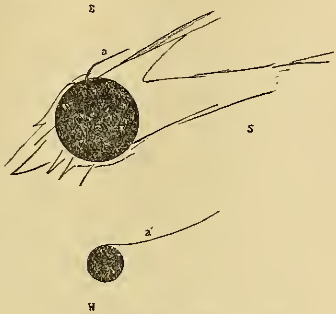
So, also, the relative geological ages of rock sections more or less remote from one another is now capable of being determined with great accuracy by methods other than the use of fossils. Modern stratigraphy rests upon grounds wholly different from what it did even a few years ago. The exact position of a terrane in the general geological column is now not so important as the relative local position with reference to known associated formations. Faunal age has ceased to be any longer a vital consideration to the geologist. When he has found out what are the geological units, or terranes, and their relations to one another, he cares little or nothing about what biotic age is assigned. He has in his possession the skeleton frame work which he can, at his leisure, clothe with flesh and blood. No subsequent finding of 'Devonian' fossils in one part, 'Carboniferous' forms in another, or even 'Tertiary' species underneath all will change the ascertained relative position of his units. The disputes of 'exact geological age' according to a standard that he no longer recognizes as infallible or essential, concern him little. If the question of 'geological age' or rather 'biotic age' can be settled even approximately satisfactory to all so much the better. If not, his stratigraphic work can go on without interruption. Questions as to age according to this criterion or that, are left for those who have more time than he to answer them.

CHARLES R. KEYES.

RAPID CHANGES IN THE STRUCTURE OF THE CORONA.

TO THE EDITOR OF SCIENCE: The question as to whether rapid changes take place in the structure of the corona is an interesting one.

I send you an observation apparently indicating such a change in certain features. The phenomenon was observed independently by three members of the party with which I was connected.



The accompanying sketch is an outline of the corona drawn by Mrs. Clayton during totality at Wadesboro, N. C., on May 28, 1900. At the beginning of totality the polar streamer marked *a* in this sketch appeared convex toward the zenith but rapidly flattened and toward the end of totality appeared flat or concave toward the zenith as represented by *a′* in the smaller sketch. There appeared to be other changes taking place in the corona but these I thought might be explained by more detail becoming apparent as the eye became accustomed to the darkness.

H. HELM CLAYTON.

BLUE HILL METEOROLOGICAL OBSERVATORY,
July 4, 1900.

NOTES ON INORGANIC CHEMISTRY.

IN the March number of *Leopoldina*, which is published at Leipzig and is the official organ of the Kaiserlichen Leopoldinisch-Carolinischen deutschen Akademie der Naturforscher, appeared an article by Professor F. Fittica of Marburg, in which he claims by heating amorphous phosphorus to 200° or lower with ammonium nitrate, to have converted the phosphorus partially into arsenic. He even assigns to arsenic the formula PN_2O and writes the equation for the reaction

$$2P + 5NH_4.NO_3 = (PN_2O)_2O_3 + 10\ H_2O + 3N_2.$$

Apparently from the relative obscurity of the journal in which the paper was published, these remarkable claims seem to have attracted little notice till quite recently, but in the last *Berichte* Professor Clemens Winkler of Freiberg takes up the subject and shows that Fittica's conclusions rest upon an '*ungeheueren Irrthum.*' Most phosphorus contains more or less arsenic—up to 2.64 %—derived from the sulfuric acid used in its manufacture. That Fittica claims to have converted eight to ten per cent. of phosphorus into arsenic Winkler considers merely an estimate. To prove the matter positively Winkler took a specimen of carefully washed and dried amorphous phosphorus and oxidized it in two gram portions with (1) ammonium nitrate, with (2) dilute nitric acid, with (3) chlorin, and with (4) alkaline hydrogen peroxid. The percentages of arsenic found in the phosphorus were as follows:

(1) Oxidation with ammonium nitrate (Fittica's method)	1.910 %
(2) Oxidation with nitric acid	1.925 %
(3) " " chlorin	1.920 %
(4) " " hydrogen peroxid	1.920 %

This shows conclusively that all the arsenic obtained by the oxidation of phosphorus by ammonium nitrate was originally present in the phosphorus.

The closing paragraph of Dr. Winkler's paper is worth quoting entire:* "It must be admitted that this occurrence, the consideration of which I have most unwillingly undertaken, has a very grave background. It almost seems as if of late in the pursuit of inorganic chemistry, there is present a dangerous tendency to enter upon speculations, without paying any attention to that thoroughness which has heretofore characterized German research. For the cases multiply where it is apparent that the theory has been first formed, and then the effort made to find the facts one wishes to find, or where one starts out from what the Leipzig physiologist Czermak calls 'inaccurately observed facts,' and hence soon falls into error. The reason for this is to no small degree to be found in the fact that the art of analysis has suffered an unfortunate retrogression. I use the word *art* intentionally, for between analysis and analysis

Ber. d. deutsch. chem. Gesell.* **33: 1696 (1900).

may be a difference as great as that between the work of the sculptor and of the stonemason. Analytical skill is not to be expected of the physicist, whose field of research with the development of electrolysis begins to encroach more and more upon the domain of inorganic chemistry; but even without this he can make great attainments in his own province. But physical chemistry is by no means identical with inorganic chemistry; for inorganic chemistry, so far from being a secluded science, presents an unlimited number of problems, whose solution must be sought along quite other lines than those indicated by the theory of ions. The really successful carrying out of inorganic chemical research is only possible for the man who is not merely a theoretical chemist but also an expert analyst, not only a practically trained, mechanical workman, but a thoughtful educated artist; the theory of every operation he carries out must be very clearly in his mind, stoichiometry must be transformed for him into living flesh and blood, and in all that he does, he must be inspired by an esthetic spirit, by a sense of order and neatness, and above all by a desire for the truth."

J. L. H.

NOTES ON OCEANOGRAPHY.

THE NOMENCLATURE OF SUBMARINE RELIEF.

At the Berlin International Geographical Congress a committee was appointed to discuss methods of naming the forms of submarine relief. That some common system should be adopted is plain, yet a vigorous paper by Dr. A. Supan sustains the thesis that the existing nomenclature is both insufficient and ill-advised. He proposes an almost wholly new scheme intended to remedy these shortcomings (*Petermann's Geog. Mittheilungen*, vol. 45, p. 177, 1899, with map). In several important respects his system stands in contrast with the usage which has gradually grown up and has crystallized in the maps published by Sir John Murray in the Summary Report of the *Challenger* Expedition and in Murray's supplementary chart recently printed in the *Geographical Journal* (Vol. XIV., p. 426, 1899).

The depressions are, by Murray, in the main generically differentiated and named on a purely bathymetric basis, forty-three of them over three thousand fathoms in depth being called 'deeps,' and each of fourteen shallower depressions receiving the name 'basin.' Supan objects to this method and emphasizes the expedience of so naming these forms that their orographic relationships may appear. Thus his 'Atakama-Graben' is so distinct an orographic unit that it does not seem well to refer to this great trench only under the names of the five 'deeps' which Murray has mapped off the coast of Chili. Throwing out the term 'deep' entirely, Supan has used 'Becken' (basin), 'Graben' (trough), 'Mulde' and 'Bucht' (for which satisfactory translations into English are desired). These are intended to describe all the types of depression yet discovered outside of the continental shelf. They are distinguished by form, not by absolute depth. The principle is a good one; yet it does not follow that the bathymetric element in our charts should be entirely restricted to what the isobaths tell us. Murray's 'deeps' are far too interesting and important not to deserve special names, and his system might well be combined with that of Supan. We think it would be to their mutual benefit.

The chief difference in the naming of elevations appears in Supan's 'Schwelle' (Swell) for Murray's 'Plateau'; the German term certainly seems the more fitting.

But a still greater contrast between the two systems subsists in the names given to individual elevations and depressions. Here again it is a matter of the principle involved. Murray has watched the growth of the older nomenclature, and, with the traditon of the naturalist in his support, has given preference to names having the priority. These names were given at various times and but slowly. Exploring vessels, commanders and naturalists were commonly honored in the application of their names to the newly discovered basins, deeps, ridges and plateaus. Supan properly dwells upon the fact that these names give no clue to the location of the corresponding forms. He, on the other hand, employs the one principle of giving submarine forms names which will relate them at once to well-known parts of the continents or to the grand ocean basins. His 'Fidschi-

Becken' is Murray's 'Gazelle Basin,' his 'Japanischer Graben,' the famous 'Tuscarora Deep,' and his 'Atlantische Schwelle' include the 'Dolphin,' 'Connecting' and 'Challenger plateaus of Murrays maps. One consequence of the difference in method is that but six of Supan's names are identical with those of Murray, although thirty-nine of the former and fifty-six of the latter relate to the same portion of the sea-bed. Such a state of affairs needs immediate attention if confusion is to be avoided in the future. Some of Supan's terms, *e. g.*, 'Chilenisch-Peruanisches Becken,' are, at the least, inconvenient; the 'Nordmeer Becken' 'Murray's Arctic Basin') is to the Anglo-Saxon ear possibly ambiguous. Yet, on the whole, Supan's names are well chosen.

In the two systems sharper definitions of the terms 'plateau,' 'swell,' 'ridge,' 'bank,' 'rise,' 'trough,' and 'basin' are necessary. As yet we have no clear statement as to the characteristic features of any one of them. Size, shape, depth and slopes should have some sort of limitations for each type, and, difficult as it may be to set bounds where one type passes into another, yet, for purposes of presentation and of understanding the subject of submarine topography, we believe that the attempt should be made. In any case, it is manifest that we have not, at the present time, secured a complete list of even the larger forms of the sea-bottom. The recent discoveries of the 'Moser Deep,' the 'Nero Deep' and the 'Reykjanaës Ridge,' the last-mentioned is the best known of all the great basins, show this conclusively. When, in addition, we reflect that the lesser details of suboceanic relief are yet to be determined, we may well ask if the future more or less complex system of nomenclature should be definitively impaired by too close adherence to the doctrine of priority, or, on the other hand, by a too hasty acceptance of new views. What is needed is a classification of forms which will include not only those already discovered but also the many expected in future exploration. It is to be hoped that the committee will succeed in finding out the right way. In one respect their task is comparatively light; if changes in the existing nomenclature are necessary, they will now meet with a minimum of prejudice either academic or of other sort. The habit of but one generation, and, indeed, of but a few of the world's broadest and best trained scientific men needs to be affected in order to secure a firm foundation upon which may be based a classification suitable for needed expansion.

THE LITHOLOGY OF ANCIENT MARINE SEDIMENTS.

Attention should be called to the elaborate 'Contribution à l'étude micrographique des terrains sédimentaires' by Cayeux (Mémoire de la Soc. Géol. du Nord, t. iv, Mém. No. 2, Lille, 1897). He concludes, after a painstaking study of the Cretaceous sediments of France and of England, that the chalk must be regarded as having been deposited in comparatively shallow water. It is thus important to note that the doctrine of Continental permanence is not invalidated by this latest and most detailed examination of the London and Paris Basin beds. Cayeux proposes to add to our classification of oceanic sediments by recognizing, with the terrigenous and pelagic deposits, a third class, the 'benthogenic,' which are composed principally of the remains of bottom organisms. Examples are cited in the bryozoal beds of Senonian limestones and in the Cretaceous strata made up essentially of sponge spicules, his 'spongolith.' He discusses at length the problem of glauconite, and finds conclusive evidence that it may be found either by the intervention of decaying animal matter or by simple secondary crystallization in the absence of organic substance. He lays stress on a new class of ancient marine sediments distinguished from the more usual sandstones by the presence of a high proportion of silica soluble in alkalies (allied to opal). While the rock may consist of from 76 to 92 per cent. of silica, no more than 50 per cent. is clastic quartz, the rest of the silica being accounted for by this soluble diagenetic form. This type of sandstone, the 'gaize' of French geologists, Cayeux would have permanently introduced into our classification of sediments.

Reginald A. Daly.
Harvard University.

ZOOLOGICAL NOTES.

A SHORT time ago two tusks of an African elephant were noted in SCIENCE, weighing respectively 224 and 239 pounds. Messrs. Tiffany & Co., in whose rooms these tusks are now on exhibition, have kindly given the following measurements of these huge tusks: Length 10 feet and ¾ inches and 10 feet 3½ inches; circumference 23 inches and 24½ inches. Sir Samuel Baker gives the weights of the two largest tusks that came under his observation as 188 and 172 pounds, but says that the average weight of a pair of tusks of the African elephant is 140, one being usually about ten pounds heavier than the other.

The weight of the tusks of the extinct *Elephas ganesa* is unknown, but so far as the dimensions can be taken from a cast the measurements are as follows: Length 12 feet 4 inches, circumference 2 feet 3 inches.

One of the largest, if not the largest, of Mammoth tusks is one brought from Alaska by Mr. Jay Beach of Oakland, Cal. This is 12 feet 10 inches long and 22½ inches in circumference and weighs about 200 pounds. The average Mammoth tusk is from 7 to 9 feet long and 60 to 80 pounds in weight.

The tusks of the Mastodon seem as a rule to be a little more robust than those of the Mammoth and to taper more rapidly, a large tusk is 9 feet 4 inches long and 23 inches in circumference.

A large deposit of fossil bones has been found near Kimmswick, Mo., and excavations are being made by a company formed for that purpose. Many bones of the Mastodon have been exhumed as well as those of Bison and other animals. The locality is thought to have been an ancient salt lick about which the animals became mired as at Big Bone Lick, Kentucky.

A miner has filed a claim in Death Valley, California, for the purpose of excavating the bones of three Mastodons which were discovered in the spring of this year and another claim has been taken out for mining a Pliocene whale in southern California.

DR. J. L. WORTMAN recently called my attention to the fact that text-books of comparative anatomy state that the lachrymal bone is wanting in pinnipeds, at the same time saying that his own belief was that examination of good specimens would show that this bone was present in young animals. Material in the U. S. National Museum enabled me to completely verify Dr. Wortman's prediction, for the lachrymal is present in fœtal or very young fur seals, *Callorhinus*, although at an early date it fuses so completely with the maxillary that, as a rule, all traces of it are lost within a month or six weeks after birth.

The lachrymal is a thin, scale-like bone, applied to the posterior face of the orbital portion of the maxillary and in a small fœtus there is a distinct lachrymal process and lachrymal foramen, the bone projecting slightly beyond the maxillary. At this stage the growth of the lachrymal is arrested and the maxillary soon comes to project beyond it, while later on the two bones fuse and all trace of the lachrymal is lost. The same thing evidently occurs in *Otaria* and *Eumetopias*, as in skulls of the young of these two genera the lachrymal is indicated by a suture which is completely obliterated in adult animals.

F. A. LUCAS.

BOTANICAL NOTES.

GENERA OF AMERICAN GRASSES.

PROFESSOR LAMSON-SCRIBNER, Agrostologist of the United States Department of Agriculture, has issued as Bulletin No. 20, a useful little book of about two hundred pages, bearing the title of 'American Grasses, III,' containing descriptions of the tribes and genera of the grasses of North America. Each one of the 137 genera is illustrated by drawings of the plant with enlarged details of spikelets, flowers, grains, etc. These genera are distributed among the thirteen commonly recognized tribes as follows: Maydeae, 4; Andropogoneae, 9; Osterdamiae, 4; Tristegineae, none; Paniceae, 11; Oryzeae, 7; Phalarideae, 3; Agrostideae, 26; Aveneae, 8; Chloridcae, 13; Festuceae, 40; Hordeae, 11; Bambuseae, 1. Ample keys make it easy to distinguish the tribes and genera, and the descriptions of both are full and apparently well drawn. This volume closes with a bibliography of works cited on its pages, and au index of Latin and English names.

WEEDS OF THE NORTHWEST TERRITORIES.

THE bulletin on 'Noxious Weeds and How to Destroy Them,' prepared by T. W. Willing, Territorial Weed Inspector, and published by the Department of Agriculture of the Government of the Northwest Territories of Canada, contains matter of botanical as well as agricultural interest. It is curious to notice that some plants which elsewhere are never thought of as weedy in their habits are catalogued in the 'list of the worst weeds.' Thus we find that *Hierochloe borealis* (now known as *Savastana odorata*) is spoken of as 'one of the most troublesome weeds in the Northwest Territories.' One is surprised at finding in the 'list of worst weeds' such elsewhere harmless plants as the common white anemone (*Anemone dichotoma*), the golden fumitory (*Corydalis aurea*), the spider flower (*Cleome integrifolia*), the erect cinquefoil (*Potentilla norvegica*), Silver-weed (*Potentilla anserina*), etc.; and also that some of the most common weeds of other regions are omitted, for example, crab-grass (*Panicum sanguinale*), green foxtail (*Chaetochloa viridis*), yellow foxtail (*C. glauca*), jimson weed (*Datura stramonium*), purslane (*Portulaca oleracea*), oxeye daisy (*Chrysanthemum leucanthemum*), burdock (*Arctium lappa*) and dandelion (*Taraxacum taraxacum*).

THE FERNS AND FLOWERING PLANTS OF OKLAHOMA.

PROFESSOR E. E. BOGUE, of the Oklahoma Experiment Station, publishes as Bulletin 45 a list of the ferns and flowering plants of Oklahoma. It is the first attempt at such a catalogue, and the author disclaims completeness for it, yet it is more than ordinarily interesting, since so little has been published in regard to the flora of the territory that it is to most botanists a *terra incognita*. Looking over the list we find 13 Pteridophyta, but one Gymnosperm (*Juniperus virginiana*), 99 Gramineae, but one Orchid (*Gyrostachys gracilis*), 131 Compositae, etc. There are 30 species of trees, including hickories (3 species), the black walnut, cottonwood, willows (3), oaks (5), hackberries (2), elms (2), mulberry, sycamore, hawthorn, wild plum, red-bud, honey locust, Kentucky coffee-tree, box elder, China tree, woolly buckthorn, persimmon, and ashes (2). One is struck by the absence from this list of bass-wood, crab apple, wild cherry, maple, ironwood, and birch. Among herbaceous plants we notice 12 species of *Eragrostis*, 13 of *Panicum*, 15 of *Polygonum*, 5 of *Astragalus*, 7 of *Lespedeza*, 6 of *Psoralea*, 14 of *Euphorbia*, 4 of *Convolvulus*, 6 of *Ipomoea*, 7 of *Verbena*, 6 of *Physalis*, 6 of *Solanum*, 8 of *Plantago*, 6 of *Artemesia*, 10 of *Helianthus*, etc. There is no *Lilium*, *Taraxacum*, *Hepatica*, *Phlox*, nor any species of *Ericaceae*, but oddly there is a *Claytonia*, a *Castalia*, an *Aquilegia*, *Lobelia cardinalis*, and *Chrysanthemum leucanthemum*. We shall look with interest for further results of Professor Bogue's studies of this interesting flora.

NORTH AMERICAN FOX-TAIL GRASSES.

THE American species of the weedy grasses known as Fox-tail or Pigeon grasses, and which were until recently described under the generic name of *Setaria* have been carefully revised by Professor Lamson-Scribner in a recent bulletin (No. 21) of the Division of Agrostology, of the United States Department of Agriculture. The name *Setaria* having fallen into synonymy, and the autonomy of the genus making *Panicum* impossible, *Chamaerophis* and later *Ixophorus* were suggested, only to be discarded after further study, these genera being clearly distinct from the grasses under consideration. Nothing remained but to re-christen the genus, which was done in 1897 (Bull. 4), with the name *Chaetochloa*. Accordingly these grasses should now bear this generic name instead of *Setaria*, or any of the others mentioned above.

In the present paper 23 species and 12 varieties are described, nine of which are new to science, viz: *C. gibbosa* from Texas and Mexico; *C. hispida*, Cuba; *C. leucopila*, Mexico; *C. rigida*, lower California; *C. latifolia breviseta*, Mexico; *C. macrosperma*, Florida and Texas; *C. villosissima*, Texas; *C. grisebachii ampla*, New Mexico and Mexico; *C. grisebachii mexicana*, Mexico. The more common species in the United States are *C. Glauca*, Yellow Fox-tail; *C. verticillata*, Hispid Fox-tail; *C. viridis*, Green Fox-tail; *C. italica*, Millet; and *C. italica germanica*, Hungarian Grass. The paper closes with lists of excluded (11) and doubtful (12) species, and a good index.

MOSSES OF THE CASCADE MOUNTAINS.

Under this title the Cambridge Botanical Supply Company is publishing sets of mosses collected by J. A. Allen, in 1898, in the Cascade Mountains of Washington. Each set contains 147 numbers, one of which (56. *Pohlia porosa*) is new to science, and another (46. *Zygodon rupestris*) is new to North America. The determinations have been made by Mrs. E. G. Britton, with the aid of Geo. N. Best, J. Cardot, Harold Lindberg, F. Renauld and others. An examination of the specimens shows them to be ample and well preserved. The collection is a notable addition to the exsiccati of Western North American Mosses.

Charles E. Bessey.

The University of Nebraska.

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*ACTIVITY IN MAGNETIC WORK.**

Magnetic Survey of Wurtemburg.—Work on this survey, under the direction of Professor August Schmidt, will be begun during present summer.

Magnetic Survey of the Azores.—Captain F. A. Chaves writes, that the magnetic survey of the Azores was begun last year, and that he has established at Ponta Delgada a declinometer for eye-readings, with the aid of which he will reduce the field observations to the same moment of time.

Magnetic Work in Japan.—In Japan, complete photographic registrations of the variations of magnetic elements are now being continuously made at the Central Meteorological Observatory, and the four stations belonging to the Earthquake Investigation Committee, viz:

	Lat. (North)	Long. (E. of Gr.)
The Meteorological Station, Nemuro.......	43° 20′	145° 35
The Second Higher School, Sendai.........	38 15	140 52
Central Meteorological Observatory, Tokio.	35 41	139 45
The Meteorological Station, Nagoya........	35 10	136 55
The Fifth Higher School, Kumamoto......	32 48	130 42

All these stations are provided with a set of Mascart's self-registering magnetograph, and the instruments for direct measurements. The daily records are all dispatched without delay to the Central Meteorological Observatory for comparative investigations.

* From advance proofs of *Terrestrial Magnetism and Atmospheric Electricity.*

Since 1897, at the Central Meteorological Observatory, the absolute measurements of magnetic elements are being taken once a month. The instruments with which the measurements are carried out are the declinometer, vibration and deflection apparatus constructed by Professor Tanakadatè, of the Tokio Imperial University, and a dip circle of Kew pattern.

The buildings at all the stations are constructed of wood, with exclusion of iron, and the supports for instruments are made of granite, or marble, placed on the masonry work of white bricks which are free from magnetic ingredients.

The extreme dampness of the soil in this country renders it difficult to use underground rooms, which are very desirable for constancy of temperature. On this account the buildings at the four stations, except at Tokio, are made above the surface of the ground, and great care is taken to keep off the sudden changes in temperature.

At Tokio, besides the underground rooms for the variation instruments there is also a building for absolute measurements, constructed with proper precautions against any disturbing influence.

The first annual report on the observations of terrestrial magnetism and atmospheric electricity made at the Central Meteorological Observatory is now passing through the press.

The precise account of the recent magnetic survey in Japan carried out under Professor Tanakadatè, we understand, is to appear shortly in the *Journal of the College of Science*, Tokio. The first and second papers of the magnetic survey made in this country several years ago have already been published in the same Journal.

Magnetic Survey of the United States and Countries under its Jurisdiction.—The Congress of the United States has appropriated for field expenses, and purchase of magnetic instruments during fiscal year, July 1, 1900, to July 1, 1901, the sum of $25,000; this is exclusive of office expenses and salaries of permanent employees. The field work is fairly well under way. Ten complete magnetic outfits are now in use by observers in various parts of the United States and Alaska. A site for the standard

Magnetic Observatory or Principal Magnetic Base Station, near Washington, D. C., has been selected, and the erection of the buildings is now in progress. A temporary magnetic observatory, equipped with the Eschenhagen magnetograph, is in operation at Baldwin, Kansas. Sites for the magnetic observatories in Alaska and Hawaiian Islands will also soon be selected, and the erection of the necessary buildings will begin within a year. At certain specified times simultaneous observations, at present simply of declination, are made by all the magnetic parties, in which important work, beginning with September, various universities distributed over the entire country will co-operate.

Magnetic Observatory at Tacubaya, Mexico.—Senor Moreno sends us the following information: "In the beginning of last year, having finished our magnetic department we installed the apparatus and began taking observations in March. A little later we were obliged to take out the apparatus on account of the excessive humidity which appeared in two of the subterranean rooms. After the rainy season had passed some provisions were made to prevent the recurrence of dampness in the future, and we were successful to the extent that the two rooms mentioned are entirely dry. On the 5th of February of this year we began anew our observations with three direct reading instruments."

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*JENNER INSTITUTE OF PREVENTIVE MEDICINE.**

THE annual general meeting of the Jenner Institute of Preventive Medicine was held at Chelsea on June 29th last, under the chairmanship of Lord Lister. Among those present were Sir Joseph Fayrer, Surgeon-General Hooper, Professor Greenfield, Professor Simpson, Dr. McCrury, Dr. Bridgwater, Colonel Addison, and Mr. Shattock. The governing body reported that the transference of Lord Iveagh's gift for the promotion of the objects of the Institute had been effected, and a governing body which would in future control its affairs had been constituted. The Director (Dr. Allan Macfadyen) reported satisfactory progress in the work of the Institute during the past year. The fitting up of the Institute buildings, with the exception of the museum, was now completed. Among other additions during the year were a physiological room, a room for incubating purposes, and a cold-storage room.

Mr. Briggs had presented a Hansen apparatus for yeast culture, and considerable additions had been made to the library. The second volume of the *Transactions* contained nineteen contributions and included a paper by Professor Ehrlich. Three papers had been communicated to the Royal Society on the influence of the temperature of liquid air and hydrogen upon bacterial life. The experiments were conducted with the kind co-operation of Professor Dewar and a further series was contemplated. In conjunction with Dr. Morris and Mr. Rowland a paper has been submitted to the Royal Society on Expressed Yeast-cell Plasma (Buchner's 'Zymase'), and the research had discovered a new method for triturating organisms. Systematic investigations were being carried out in the bacteriological department upon enteric fever, tuberculosis, and the etiology of cancer, with the co-operation of Dr. Hewlett and Mr. Rowland. Various investigations had been published during the year by Dr. Hewlett and other members of the staff. It was proposed to set on foot a systematic inquiry into the nature and origin of food poisons. A number of workers had utilized the laboratories for purposes of research during the year. Special investigations had been carried out for public authorities during the year on tubercle in milk, on glanders and anthrax, and other subjects.

The illustrations for the *Transactions* had been prepared by Mr. J. E. Barnard in the photographic department of the Institute. Dr. Harden, chemist to the Institute, was continuing his investigations on the chemical products of pathogenic and other micro-organisms. Dr. Harris Morris, lecturer on Technical Mycology, reported that a number of students had made use of the Hansen Laboratory, and that researches on yeasts, diastases, zymase, and other subjects of technical interest had been prosecuted. Dr. George Dean of the antitoxin department, had made experiments on the best conditions for obtaining powerful toxins and

* From the *British Medical Journal.*

antitoxins, and the results of other workers had been tested; as a result a higher average of antitoxic value had been reached. Several races of streptococcus pyogenes had been used in immunizing horses with the view of obtaining a polyvalent serum. Researches dealing with problems of immunity were in progress, and papers had been published in the diphtheria bacillus and a new pathogenic streptothrix.

THE BRITISH NATIONAL PHYSICAL LABORATORY.

A DEPUTATION of prominent English men of science waited on the financial Secretary of the Treasury, Mr. Hanbury, M. P., on June 5th with the object of securing a site in the Old Deer Park, Richmond, for the new National Physical Laboratory. Another deputation had an interview with Mr. Hanbury a few days before to protest against the proposed buildings as an interference with the amenities of Kew Gardens, and it was to meet their objections that the present deputation waited upon Mr. Hanbury. Amongst those present were Lord Lister, Lord Rayleigh, Lord Kelvin, Sir Courtney Boyle, Sir John Wolfe Barry, Sir M. Foster, M.P., Sir E. Carbutt, Sir N. Barnaby, Sir Andrew Noble, and Professors Rücker, Clifton, Schuster, Fitzgerald and Elliott.

According to the report in the London *Times* Lord Lister said the Royal Society was deeply interested in the question of the new National Physical Laboratory, and they were supported by all the scientific bodies in the kingdom.

Lord Rayleigh, as Chairman of the National Physical Laboratory, said they recommended "That the institution should be established by extending the Kew Observatory in the Old Deer Park, Richmond, and that the scheme should include the improvement of the existing buildings at some distance from the present observatory." They had already the Kew Observatory, which had been doing very valuable work cognate to that proposed to be undertaken by the new institution, and that alone suggested the Deer Park as a natural site. Besides, there were very few sites that were likely to be at all suitable, because the character of the work to be carried out was of the kind to be removed from all kinds of mechanical and electrical disturbances. Electrical disturbance was a new feature, but one that might be made from tramways anywhere. On that ground no private site could meet the case, because there was no security from buildings of other kinds creating mechanical and electrical disturbances.

This consideration greatly limited their choice of sites for this laboratory. That principle was recognized by the Greenwich Observatory being placed in the middle of a park; the German institution at Potsdam was in a park; and the International Bureau of Weights and Measures stood in the park of Sèvres. In a public park they had some guarantee that the buildings would be free from electrical and other disturbances. Some comment had been made on the provisional arrangement with the woods and forests as to the 15 acres required. One of the reasons for that large area being taken was that they wanted one of their buildings to be at a considerable distance from the other. It had never been proposed to cover the whole 15 acres with buildings. The actual area proposed to be covered with buildings was only a quarter of an acre, or the 60th part of the whole area proposed to be taken.

Sir John Wolfe-Barry said that he was placed on the committee which recommended this site for the laboratory as the representative of applied science, numbering 9000 members, and the general opinion was that it was extremely important to establish this physical laboratory from the point of view of the trade of this country and the huge commercial interests at stake. The committee gave the greatest possible attention to the question of site, and they came to the conclusion that Kew was very suitable. The one thing they had in view was quiet, and Kew possessed advantages which could not be given at any other place within a reasonable distance of London. It was easily accessible and it was quiet. They wanted a good space because they did not want the public to approach too near.

Mr. Hanbury, in reply, said: I hope the deputation are under no misapprehension whatever as to our strong desire that this scheme for a physical laboratory should be carried out.

The money has been promised, and we are anxious to find a site. As to the absolute importance to the country of having a laboratory of that kind there is no doubt whatever. That is not the question raised by the Treasury or by any deputation. The real difficulty has been how far this undertaking would interfere with the amenities of Kew Gardens. We want, so far as we can, to satisfy both the scientists and lovers of nature. Undoubtedly there has been some alarm among a certain portion of the public, especially those interested in Kew Gardens and open spaces, that this might to a certain extent interfere with the amenities of Kew. I am bound to say that the impression gathered from you to-day is that to a great extent that alarm is unnecessary. Of course the deputation represented to me the other day the danger of the quiet being disturbed by the noise of the operations in the two proposed buildings, and from what Lord Kelvin and others have said to day I am satisfied that on that point, at any rate, there need not be any alarm. The most important point that has come out to day is as to whether after all on this site you are yourselves secure against electrical disturbance. I need not express any opinion upon that. We ought to wait for the report of the Board of Trade committee to see how far that will meet your requirements. I understand that if there is any extension of the buildings required it will be only to a little extent, and the public need not fear that you will build over the whole of these 15 acres.

PROTECTION AND IMPORTATION OF BIRDS.

DURING the last session of Congress a law was enacted, commonly known as the Lacey Act, which places the preservation, distribution, introduction, and restoration of game and other birds under the Department of Agriculture; regulates the importation of foreign birds and animals, prohibiting absolutely the introduction of certain injurious species; and prohibits interstate traffic in birds or game killed in violation of State laws.

The Secretary of Agriculture has placed the Division of Biological Survey of his Department in charge of all matters relating to the preservation and importation of animals or birds under the Act, and Dr. T. S. Palmer, the Assistant Chief of that Division, has immediate charge of the issue of permits for the importation of animals and birds from foreign countries.

The regulations for carrying out the purposes of the Act have just been published by the U. S. Department of Agriculture as Biological Survey Circular No. 29, entitled 'Protection and Importation of Birds under Act of Congress approved May 25, 1900.'

The circular explains the object of placing the work in charge of an Executive Department of the Federal Government as being merely to supplement and not to hamper or replace the work hitherto done by State commissions and organizations; in other words, to co-ordinate and direct individual efforts, and thus insure more uniform and more satisfactory results than could otherwise be obtained.

Attention is called to the fact that while the Act provides for the purchase and distribution of birds, no appropriation is made for that purpose. The Department, therefore, has no quail, pheasants, or other game birds for distribution.

The Department issues no permits for shipping birds *from one State to another*. In some States the Board of Fish and Game Commissioners is authorized to issue permits for shipping birds for propagating purposes, and a few States make exceptions in their game laws in the case of birds captured for breeding purposes; but when a State forbids the exportation of birds without exception, interstate commerce in birds from that State is in violation of the Lacey Act, whether the birds are captured during open seasons or whether they are intended for propagation or not.

Persons contemplating the importation of live animals or birds from abroad must obtain a special permit from the Secretary of Agriculture, and importers are advised to make application for permits in advance, in order to avoid annoyance and delay when shipments reach the custom house. The law applies to single mammals, birds or reptiles, kept in cages as pets, as well as to large consignments intended for propagation in captivity or otherwise.

Permits are *not* required for domesticated birds, such as chickens, ducks, geese, guinea fowl, pea fowl, pigeons, or canaries; for parrots (including cockatoos, lovebirds, macaws, and parrakeets); or for natural history specimens for museums or scientific collections. Permits must be obtained for all wild species of pigeons and ducks.

In the case of ruminants (including deer, elk, moose, antelopes, and also camels and llamas), permits will be issued, as heretofore, in the form prescribed for importation of domesticated animals.

The introduction of the English or European house sparrow, the starling, the fruit bat or flying fox, and the mongoose, known also as the ichneumon or Pharaoh's rat, *is absolutely prohibited, and permits for their importation will not be issued under any circumstances.*

Under the regulations prescribed by the Secretary of the Treasury, in case of doubt as to whether animals or birds belong to the prohibited species, or suspicion on the part of the collector of customs that such species are being entered under other names, the shipment will be held, at the risk and expense of the importer, pending the receipt of special instructions from the Department of Agriculture, or until examined at the expense of the importer by a special inspector designated by the Secretary of Agriculture and the identity established to the satisfaction of the collector.

Special inspectors will be designated at the ports of New York, Boston, Philadelphia, Baltimore, Washington, New Orleans and San Francisco, who will examine shipments at the request of the owner or agent, or who may be consulted in case of misunderstanding between owners and officers of the customs. These inspectors are to be designated merely for the convenience of importers, and owners or agents are under no obligations to employ them, but the identity of the species must be established to the satisfaction of collectors, and in case of refusal or neglect, or failure to obtain the permit within the specified time, delivery of the property will be refused and immediate exportation required.

The deliberate shipment of starlings or English sparrows from one State to another is now a violation of law and renders the shipper and carrier liable to the penalties provided in the Act.

The attention of sportsmen, commission merchants, shippers, and express agents is especially called to the sections which make it unlawful to ship from one State to another animals or birds which have been killed or captured in violation of local laws, and which require all packages containing animals or birds to be plainly marked so that the name and address of the shipper and the nature of the contents may be ascertained by inspection of the outside of such packages.

MONUMENT TO PROFESSOR BAIRD.

At the annual meeting of the American Fisheries Society held at Woods Holl, July 18–20, Dr. H. M. Smith, of the U. S. Commission of Fish and Fisheries, spoke of the appropriateness of the Society erecting at Woods Holl a memorial to the late Professor Spencer F. Baird, and presented the following resolutions which were unanimously adopted:

Whereas, The American Fisheries Society, assembled at Woods Holl, Mass., regards as desirable and proper the erection of a tablet or monument to the memory of the late Professor Spencer F. Baird, in recognition of his distinguished labors in behalf of fish-culture, the fisheries and biological science; and

Whereas, The Society deems it appropriate that this memorial should be located at Woods Holl, as a special tribute to his zeal in furthering the interests of marine biology and fish-culture; therefore,

Resolved, That a committee with full powers be appointed by the chair to determine the most suitable form of the memorial, to raise the necessary funds, and to proceed with the erection of the monument.

Resolved, That the committee notify the surviving members of Professor Baird's family of the proposed action, and invite their suggestions thereon.

Resolved, That a copy of these resolutions be transmitted to the U. S. Commissioner of Fish and Fisheries.

The following committee was appointed, pursuant to the foregoing resolutions: Dr. H. M. Smith (Chairman), Washington, D. C.; Hon. E. G. Blackford, N. Y.; Dr. E. W. Blatchford, Ills.; Hon. George M. Bowers, Washington, D. C.; Mr. Frank N. Clark, Mich.; Mr. Vinal N. Edwards, Mass.; Dr. Bushrod W. James, Penna.; Hon. George F. Peabody, Wis.; Hon. Redfield Proctor, Vt.; Mr. W. de C. Ravenel, Washington, D. C.

SCIENTIFIC NOTES AND NEWS.

VICTORIA UNIVERSITY conferred at Manchester on June 30th, honorary degrees upon Lord Rayleigh, Sir William Huggins, Sir W. C. Roberts Austen, Sir William Abney, Dr. T. E. Thorpe, Professor J. Dewar, Professor A. R. Forsyth, Mr. R. T. Glazebrook, Professor E. C. Pickering, Professor J. J. Thomson and Mr. Henry Wilde.

THE Hopkins prize of Cambridge University for the period 1894–1897 has been awarded to Mr. J. Larmor, F.R.S., of St. John's College, for his investigations on the 'Physics of the Aether' and other contributions to mathematical physics.

SIR MICHAEL FOSTER arrived in New York by the steamship *Lucania* on July 21st. He will give a course of lectures before the Cooper Medical College, San Francisco, and will make arrangements for American co-operation in the International Catalogue of Scientific Literature.

PROFESSOR J. MARK BALDWIN, of Princeton University, has returned to the United States after a residence of over a year at Oxford, where he has been seeing through the press the 'Dictionary of Psychology and Philosophy' shortly to be published by The Macmillan Company.

DR. EMORY MCCLINTOCK has returned from Paris, where he attended the third international Congress of actuaries as delegate from the U. S. Government.

THE Paris Academy of Sciences has elected M. Bazin of Dijon a correspondent for the section of mechanics and M. Zambacca a correspondent for the section of medicine and surgery.

DR. CORFIELD, professor of hygiene and public health at University College, London, has been elected a corresponding member of the Royal Academy of Medicine of Belgium.

DR. NICHOLAS SENN, who served as a volunteer medical officer during the war with Spain, has again offered the United States government his services, to go to China to care for the American soldiers who may be wounded. As volunteer in the Spanish-American war Dr. Senn went to Cuba, where he was chief operating-surgeon in the field with the rank of lieutenant-colonel.

CAPTAIN E. L. MUNSON, assistant surgeon in the United States army has been awarded the prize (one hundred dollars in gold or a medal of that value) presented to the Military Science Institution by Dr. Louis L. Seaman, for the best paper on the subject of 'The Ideal Ration for an Army in the Tropics.'

THE Managers of the Royal Institution have awarded the Actonian prize of 100 guineas to Sir William Huggins, K.C.B., F.R.S., and Lady Huggins for their work 'An Atlas of Representative Spectra.'

MR. J. H. MAIDEN, director of the Botanic Gardens at Sydney, is at present in London, and will spend about three months making special investigations in Great Britain and on the continent.

JAMES R. BAILEY, Ph.D., adjunct professor, in charge of organic chemistry in the University of Texas, will spend the coming year at Leipzig. His place will be supplied by Mr. E. Schoch, late of the University of Chicago.

MR. THOMAS LARGE has been appointed assistant in the Illinois State Laboratory of Natural History for ichthyological work on the natural history survey.

AT a recent meeting of the Board of Regents of the University of Texas (July 12th) provision was made for the appointment of an 'instructor in economic and field geology,' who should supplement the work of instruction in the University by research work in the State. This step is preliminary to the establishment of a Geological Survey under the auspices of the University.

DR. J. M. MENECK is supposed to have perished in the desert of southern Utah. He was separated from his companions while prospecting in that region, and no traces of him have been found. He was known as a geologist and archæologist and had represented the Smithsonian Institution.

THE following deaths of ornithologists are noted in the *Auk*: Edgar Leopold Layard has died at Budleigh Salterton, Devon, England, in his 76th year. He was born at Florence on July 23, 1824, and entered the Civil Service of Ceylon when twenty-two years of age; in 1855 he accepted the invitation of the late Sir George Grey to a post in the Civil Service at Cape Town. There he founded the South African Museum and became its first curator; Layard's chief work was 'The Birds of South Africa,' published in 1867, of which a new and revised edition, with the collaboration of Dr. Bowdler Sharpe, made its appearance between 1875–84. It is rather by his many and varied contributions from 1854 almost to the time of his death that he will be remembered; and a column of closely printed type in the General Subject Index to *The Ibis* testifies to his work in ornithology. Percy S. Selous, an associate member of the American Ornithologists' Union, died at his home in Greenville, Mich., on April 7, 1900. His death was due to the bite of a pet Florida moccasin. Mr. Selous was a great traveler and an enthusiastic naturalist, especially interested in birds and reptiles.

Among the British Civil List pensions granted during the year ended on June 20th, *Nature* notices the following: Mr. Benjamin Harrison, in consideration of his researches in the subject of pre-historic flint implements, 26*l.*; Mr. Thomas Whittaker, in consideration of his philosophical writings, 50*l.*; Mr. Charles James Wollaston, in recognition of his services in connection with the introduction of submarine telegraphy, 100*l.*; Mr. Robert Tucker, in consideration of his services in promoting the study of mathematics, 40*l.*; Mrs. Eliza Arlidge, in consideration of the labors of her late husband, Dr. John Thomas Arlidge, in the cause of industrial hygiene, 50*l.*; Miss Emily Victoria Biscoe, in consideration of the services rendered to Antarctic exploration by her late father, Captain John Biscoe, 30*l.*

The death is announced of Dr. Corrado Tommasi Crudeli, professor of pathological histology at Rome, one of the secretaries of the Accademia dei Lincei and known for his important researches on cholera and malaria.

By the will of the late Timothy B. Blackstone, of Chicago, $250,000 is given to public institutions, including $100,000 to the Blackstone Library at Branford, Conn., and $25,000 to the Chicago Art Institute.

The Belgian Academy of Medicine offers a prize of 1200 fr. for a research on the influence of change of temperature on nutrition. Essays must be sent before the 20th of January, 1901, to the Secretary of the Academy, Brussels.

The fiftieth anniversary of the German Ornithological Society will be celebrated at the annual meeting which will be held at Leipzig on October 5th.

The third annual meeting of the American Section of the International Association for the Testing of Materials will be held in New York, October 25th–27th. At this meeting reports of a number of committees as to proposed standard specifications will be submitted for discussion. Among these are specifications for steel axles, steel forgings, steel castings and wrought iron.

The annual meeting of the British Museums Association began at Canterbury on July 9th, under the presidency of Dr. Henry Woodward, of the British Museum.

The Victoria Institute, London, held its annual meeting on July 15th, when an address was given by Professor Hull, F.R.S.

The Jenner Institute of Preventive Medicine, London, will be taxed according to a decision of the English Courts, because it is not exclusively for purposes of science. It is held that the fact that the Institute has sold certain antitoxines prevents it being regarded as exclusively for the advancement of science.

The British Secretary of State for India has received a telegraph from the Governor of Bombay stating that there were 9928 cases of cholera in the famine districts during the week ending July 7th, of which 6474 were fatal, and that in the native States there were 9526 cases, of which 5892 were fatal. The total number of death on the relief works was 5870, which was 3.9 per 1000.

The hut in which Drs. Sambon and Low are about to make their experiments, to see whether malaria is prevented by excluding mosquitoes, is to be placed on a site about two miles from Ostia, on the edge of a swamp forming part of the royal hunting domain of Castel Fusano, and left undrained to preserve the wild animals. It is one of the most fever stricken centers of the Roman Campana and infested with innumerable mosquitoes of the malarial variety.

A BLACK bear for the N. Y. Zoological Park recently escaped while being transferred from a truck to the enclosure in the Park. It scratched Dr. Hornaday, director of the Park, and an attendant, and was strangled in the attempt to catch it.

IT is said that three of the surveying parties recently sent to Alaska by the United States Geological Survey are now at work in the Nome district and its extension in the Seward Peninsula. They are in charge of Messrs. E. C. Barnard, A. H. Brooks and W. J. Peters. Mr. Barnard will make a topographic map on a scale of four miles to the inch, and Mr. Brooks will make geological investigation covering the area thus mapped. He will determine the extent of the gold-bearing formation, and trace out the conditions of occurrence of the veins from which the placer gold has been derived. He has submitted a report which speaks of the adverse conditions prevailing at Nome. He says that large numbers of persons on the beach were without shelter or food, and verifies the reports of the presence of smallpox on the vessels, and the probability of a smallpox epidemic there. Mr. F. C. Schrader, under date of June 14th, reports the arrival of the Copper River surveying party at Valdes. This party is to make a topographic and geologic survey of an area of 3000 square miles in the Copper River region, where valuable copper deposits are reliably reported to exist.

THE *Windward* has left Sydney, B. C., for Etah, North Greenland, with supplies for the Peary expedition. It is, however, said that the ice floes this year are unusually heavy and extensive, and that the *Windward* will experience great difficulty in going North and will probably be unable to reach Etah.

THE *British Medical Journal* states that on the initiative of Professor W. D. Scherwinsky of Moscow, a permanent committee for the study of tuberculosis as a national scourge has been formed in Russia. Professor Scherwinsky himself is the President; the other members are Messrs. Ph. M. Blumenthal, G. N. Gabritschewsky, F. A. Guetier, L. J. Golubinin, G. J. Gurin, P. J. Kurshin, A. G. Petrowski, J. W. Popoff, A. D. Solokoff, and A. N. Ustinoff. The committee which has met twice a month since the beginning of April has drawn up for itself the following program of work: (1) Reports on the communications made on tuberculosis to the Pirogoff Congress and other medical societies in Russia; (2) reports of foreign congresses on tuberculosis; (3) reports on tuberculosis as an infectious disease (diagnosis, etiology—heredity, individual predisposition, external influences, mode of diffusion, economic and social factors); (4) statistical data respecting tuberculosis in Russia; (5) legislative measures and ordinances in regard to tuberculosis of human beings and beasts; (6) sanatoria, koumiss establishments, etc.; (7) the means actually in use, and which should be used, for the prevention of tuberculosis in the different provinces of Russia; (8) tuberculosis in animals and its relation to the disease in human beings.

Nature states that the grant of 1000*l.* in aid of the work of the Marine Biological Association; the site of the National Physical Laboratory at Kew; and the grant to the British School at Athens, were brought before the House of Commons upon the vote to complete the sum of 50,724*l.* for scientific investigation. It was urged by Mr. Gibson Bowles that the grant to the Marine Biological Association should be largely increased; and by Lord Balcarres that the vote of 7000*l.* for building and equipping the National Physical Laboratory should not bind the treasury to adhere to the site which has been proposed. Mr. Hanbury said it should be borne in mind that the grant of 1000*l.* to the Marine Biological Association was not the only grant made in connection with the fisheries of the United Kingdom. A grant was given to the Fishery Board of Scotland for the purpose of scientific investigation, and similar assistance was given to the Irish fisheries. Under present conditions there did not seem to be any urgent necessity to increase the grant. The Treasury has very little voice in the matter of a physical laboratory; it has acted on the recommendation of a committee of the Royal Society. It was absolutely necessary to find a site near Kew Observatory, and after looking at every possible site the committee strongly reported that no other site would answer the purpose so well as that which adjoined Kew Gardens. He agreed that nothing ought to be done which would interfere with the amenities of Kew Gardens, and this point had been considered in the selection of the site. The two buildings, one for machinery and the other for carrying on the more delicate scientific operations, were to be placed in positions which would not mar the views from the gardens or injure their amenities. The voting of the 7000*l*. would in no way prejudice the consideration of the case against the proposed site. Referring more particularly to the British School at Athens, Mr. Balfour stated that the only ground for the alarm expressed was that the original grant was for five years, and that this term was drawing to a close. The question of governmental subvention of scientific investigation was a very important subject, and there was no doubt that Great Britain had, from a traditional policy, lagged greatly behind other nations in respect. It never occurred to them to do what the Germans, the French, or the Americans did in making certain grants for investigations ; and who was right he did not undertake to say. His own personal inclination was rather in the direction of governmental aid in cases where they could not expect private aid to come forward ; but at the same time he confessed that he often thought how strange it was in a very rich country there were not found some people who, in a difficulty to find other and more profitable investments, did not attempt to earn glory for themselves by carrying on those investigations with the money that was required. He could only say that certainly the grant would not be discontinued without a generous consideration of the facts and interests involved.

UNIVERSITY AND EDUCATIONAL NEWS.

An additional story will be added to the University Hall, Columbia University, during the present year. The basement of this Hall, containing the gymnasium and power house, erected at a cost of about $1,000,000, has been in use since the University removed to its new site. The superstructure is being erected by gifts from the alumni, and enough money is now available to construct an additional story which will contain dining halls, club rooms, an assembly room, seating 1500, and some of the offices of administration. The assembly hall for the religious and social life of students for which a gift was made last spring will be begun in the autumn. During the present summer, alterations are being made in Schermerhorn Hall in order to enlarge the laboratory of psychology. A private staircase is being built from the present laboratory to the floor above where seven additional rooms for research are being provided.

At the University of Texas, Dr. S. E. Mezes has been promoted from an associate to a full professorship of philosophy and Dr. H. Y. Benedict, instructor in mathematics and astronomy has been advanced to an adjunct professorship. The regents have made provision for an instructorship in botany.

Thomas Nolen, professor of architecture in the University of Missouri, has resigned to accept a professorship in the University of Pennsylvania.

It is reported that Dr. A. Lincoln, assistant in chemistry at Cornell University, has been offered the chair of chemistry in the University of Cincinnati.

Mr. John H. McClellan has been reappointed instructor in zoology at the University of Illinois.

Dr. Precht, of the University of Heidelberg, has been promoted to an associate professorship of physics, and Dr. Fritz Czeschka von Mährenthal, curator in the Zoological Institute of the University of Berlin, to a professorship of zoology.

Professor Oreste Mattirolo has been appointed professor of botany in the University of Turin, and Dr. Fridrano Carava associate professor in this science in the University of Cagliari.

Dr. Schmidt, honorary professor of anthropology and ethnology in the University at Leipzig, has retired.

SCIENCE

FRIDAY, AUGUST 3, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE LAST QUARTER—A REMINISCENCE AND AN OUTLOOK.**

NINETY years ago, a botanist holding a professor's chair in Williams College for the supposed mismanagement of an estate in Columbia county was confined for a short period in a debtor's prison in New York City. Years afterward he related to a friend that as a relief to the monotony of confinement he found amusement in teaching botany to the keeper's son whom he described as a bright youth of fourteen years. From such an inauspicious beginning came the real development of botany in this city, for while Hosack had attempted to develop his Elgin Gardens earlier in the century, the above episode was the beginning of a career that resulted in the rapid advance of botanical science in New York. It is only proper to add that the professor above noted was no less a personage than Amos Eaton, author of the first series of American botanical manuals, and the willing pupil was none other than John Torrey, the Nestor of American Botany.

Were we tracing the full pedigree of botany in New York, it would be necessary to follow the record two generations back of Torrey, for it was Hosack, the originator of the first botanic garden of New York who instructed and assisted Amos Eaton in his early botanical studies while the latter was still a law student in New York City, and more specially after he had passed on to his higher work of instruction. Hosack's Botanical Garden at 54th Street and Madison Ave. was too far out of town for the New Yorkers of 1801–1806 to visit, and it passed over finally to Columbia College and laid a solid foundation for the financial endowment of that institution, as property

* Address of Retiring President, Botanical Society of America.

advancement followed settlement northward up Manhattan Island. It was little wonder that this college early came to foster botanical science and later accumulated the foundations that have led up to its present tender of facilities for botanical research along varied lines.

It is unnecessary in this presence to relate in detail the incidents which led up to the development of a botanical center here as early as 1831, so that Asa Gray, restive in his work in Central New York and casting about for a place where he could study botany, could find no better tutelage than under his master Torrey, and came to New York as Torrey's pupil and finally became his assistant in the preparation of the Flora of North America, a work that will ever stand as a masterpiece in American botany, combining with the critical acumen and exact learning of its senior author the enthusiasm and push of its more youthful one. It may, however, be useful at this time to call to mind some of the conditions existing at the time of the first appearance of Torrey and Gray's Flora in 1838 or even at the period of the issue of the final part of the second uncompleted volume in 1843. The great Louisiana Purchase of 1803 extending northwestward from the mouth of the Mississippi to the Pacific had scarcely been entered by the scientific explorer except in its Northern portion, and that mainly by Lewis and Clark in their discovery of the headwaters of the Columbia and by Long's expedition to the Rocky Mountains. Texas and the great Southwest, Utah, Nevada, and California were quiet, Mexico-Spanish possessions alike undisturbed by the hum of civilization or the visitation of the field botanist except as some wandering explorer like Adelbert Chamisso had touched at the Pacific ports and had skimmed a few memorials of the vast west coast flora, or some Russian expedition had pushed down from their northern possessions into Northern California. Minnesota and the Northwest were still in the hands of the Indians, and all of Iowa and much of Illinois were raw prairie untouched by the plow of the pioneer. Chicago was a hamlet with a handful of people struggling with fever and ague on the wind swept marshes at the lower end of Lake Michigan. The South which even yet has scarcely produced an indigenous botanist was then a region untouched since the travels of Michaux, except as Short and Peter had explored Kentucky and Stephen Elliot, the father of Southern botany, had brought to notice something of the flora of the Carolinas. Such in brief was the state of our country and its botanical exploration when Gray received his call to Cambridge and laid there the foundation of a second center of botanical research. The annexation of Texas as the second of our Spanish acquisitions of territory; the Mexican war with the commencement of our expansion policy in the cession of California and New Mexico with the attendant military occupation and exploration for the settlement of boundaries; the discovery of gold in California in 1848 and the attendant development of that Eldorado of immigration, and finally with the transcontinental railroad projects of the early fifties, all brought to Torrey and Gray the floral wealth of these extensions of territory and have made the Torrey herbarium at New York and the Gray herbarium at Cambridge the two great repositories of the types of western plants, each supplementing the other in their priceless possessions.

Few of the present generation of botanical students realize clearly the rapid advance of their science in the past quarter of a century or the conditions under which the student of botany was placed at the beginning of that period. It is just an even twenty-five years since your retiring president completed the solitary course in botany offered in his undergraduate collegiate work in 1875. It was a course of lectures given by a great and good man, but one whose first love was geology and not botany, and extended through a short term of twelve weeks in which we were instructed in some of the details of the structure of the flowering plants something after the pattern set in Gray's lessons, after which we were directed how to use Gray's Manual for determining the unknown names of such familiar plants as the Trillium, the spring beauty, the wild geranium and the white daisy with all the array of names like *Leucanthemum chrysanthemum* that nearly paralyzed such of the students as had pursued a long course in Greek. There was scarcely a word as to the homology of parts, relationship of plants to each other or to their environment. Not a word was breathed about the world of cryptogamic organisms; the ferns and fungi were alike tabooed, and liverworts and lichens may as well have had a non-existence for we never heard them mentioned, and went out of college ignorant of their existence at least from any direct information from the instructor. The compound microscope was sealed to us except as an illustration of the application of the principles of optics, but we well remember the half day of unalloyed pleasure when we stole into the room where it was usually securely locked in its case and for once found the case open. How we reveled in a set of prepared slides and had our first self-taught lesson in plant histology.

This personal reminiscence is not an unusual picture for those times, for then there were in the country only two or three colleges where there was a distinctive professor of botany, and even in these more favored institutions the character of the instruction was much the same as I have pictured. Ecology was unheard of in the schools; plant physiology was scarcely mentioned and indeed its only printed exponent available was 'How Plants Grow, Gray.' Evolution was some unholy doctrine about monkeys that contradicted the Bible. It was with the force of an electric shock that a short time later the translation of Sachs' Botany opened to our astounded eyes the manner in which we as students had been robbed of the knowledge of the splendid advance of the science that had been in progress in Germany during the middle half of the present century. Soon after this, Bessey's 'Botany' for schools appeared, and it is no exaggeration to say that since the time when Amos Eaton's first class in Williams College begged the privilege to publish for him the first and most famous edition of his manual, no single book has appeared that for its time has proved a more valuable contribution to botanical teaching in America. Bessey's work was particularly useful at this time because it served to introduce the younger student to Sachs' more extensive and difficult text-book and showed him that there were other and broader considerations in botany than the mere 'analysis of flowers,' and gave him for the first time a rational conception of that underworld of plant life of which the hitherto one-sided facilities for study had robbed him. Since that time wave after wave of lines of botanical investigation and methods of teaching have swept over us, and system after system of elementary instruction has been proposed and has been crystallized or more often presented in an amorphous condition in the numerous text-books and laboratory manuals of the past fifteen years.

I should add here that indirectly a second factor greatly stimulated the development of the new botany, namely the introduction of elementary biological study in the schools, for about this time Huxley's 'Biology' appeared and from an English stimulus American students commenced the development of biological investigation from a new standpoint. Laboratory methods were commenced, and laboratory equipments followed. But Huxley was mainly a zoologist, and thus not unnaturally it came about that some American biologists came to be developed in a one-sided way, and in some cases came to assume the unfortunate proposition that biology was only another name for zoology. In later years they learned their mistake and for the future the student who hopes for success along biological lines recognizes that he is committing a fatal error if he does not prepare for his future with a vigorous foundation in plant biology.

Twenty-five years ago there was practically one American botanist and his manual was supposed to be the end of all necessary knowledge even though its descriptions often failed to cover variations noted that later botanists have dared to call species. In some remote quarters the momentous question was occasionally presented to the teacher of botany, Is Gray's system really better than Wood's? but usually there was little dissent from an affirmative answer to the question.

It was in the latter part of this same year (1875) that the first number of the *Botanical Bulletin* (now the *Botanical Gazette*) was issued by the enthusiastic professor of natural science of a little college in southern Indiana. It was a four-page sheet without cover containing mainly notes on the local flora of the vicinity of the college and bearing little prophecy of its present development into two volumes aggregating nine hundred pages a year. Five years before The Torrey Club of New York had founded its *Bulletin*, but for the five years prior to 1875 had not produced so many pages as have just been issued in the first five months of the year 1900. Something of the aim of the latter journal in its early days may be of interest at this time. We quote from the first number, January, 1870: "An attentive study of plants in their native haunts is essential to the advance of the science, and in this respect the local observer has an advantage over the explorer of extensive regions, or the possessor of a general herbarium. He can note the plant from its cradle to its grave; can watch its struggles for existence, its habits, its migrations, its variations; can study its atmospheric and entomological economies; can speculate on its relations to the past, or experiment on its utility to man. It would be in vain to attempt to enumerate all the points about which a lover of vegetable nature can learn and report something new. Botany, like every other science, far from being exhausted, is ever widening its field." This language for the time in which it was written was an unexpected prophecy, for at this period scarcely anyone looked at botany as a serious subject. It was regarded as a suitable study for misses' boarding schools and a harmless elective in a few of the more enlightened colleges. No facilities were open for advanced work and none was thought of by the college authorities. A botanist to grow must delve for himself, must invent his methods, must acquire unaided the mastery of his implements of research. If, as was usually the case, he was short of means, he must either teach or practice medicine and from his overcrowded hours steal the time in which to devote himself to the object of his love. With most of us it was a literal exemplification of Agassiz' rule that to succeed as a naturalist one must 'lie hard and live low,' and many in the struggle lost their ambition and went in pursuit of more lucrative subjects.

The government, except in now and then detailing a botanist and too often an untrained one on some exploring expedition, had not yet commenced to foster botanical research. There was a botanist, to be sure, to the Department of Agriculture and he did accumulate an extensive collection so long stored in the old fire trap that, be it said to the disgrace of our Government, still serves to house this Department; and this collection, fortunate in escaping the hazards of fire, formed the nucleus of the splendid national herbarium now housed in the crowded attics of the National Museum.

Such is a faint picture of the conditions of American botany as they existed twenty-five years ago. What American botany has become to-day with its centers of scientific research scattered throughout the country from New England to the Golden Gate, with its botanical publications in a healthful and hopeful if not prosperous state of development, with its agriculture and the arts clearly recognized by the state and general governments, with the work of the experiment stations which in many states have already passed their formative stages and are entering the lists as centres of intelligent botanical research, in the forestry reserves which are already fields of practical experiment and promise also to form similar research centers, and finally in the attitude of men of thought and men of wealth who are devoting their activities of brain and purse toward better making known the importance of the plant world to man in its utility and beauty, and seeking for the advancement of botanical knowledge throughout the earth,—these are the products almost of the past two decades and measure a progress unparalleled in the history of scientific development in any country and in any age. And this progress has commenced along diverse and in some cases unexpected lines. After instruction in botany ceased to be merely the analysis of flowers, came the study of types leading the student to consider other subjects than the flowering side of plant creation opening up new lines in morphology and plant development; then came plant physiology taking inspiration from the labors of Sachs and others across the sea; then followed plant cytology from the enthusiasm kindled in the American students who for years have formed the greater number of workers in the famous laboratory at Bonn; later still plant embryology has for the time been the botanical fashion and has opened up new points of view for the study of plant relationship.

To revert once more to Amos Eaton who may be regarded not only as the pioneer of the long succession of botanical teachers in America, but as well the author of the first series of botanical manuals that have made a knowledge of our flora accessible to students, we desire to call attention to what he considered the cardinal preparation for the work of a botanical instructor "No one," said he, "should attempt to give instruction in botany who is not thoroughly familiar with at least four hundred plants." It has been reserved for the present generation to produce botanical teachers who do not know plants and those whose lack of botanical perspective becomes intensified in the successive crops of highly specialized students that come out from their instruction; and we may well emphasize this early principle which in the present generation is even more essential as the first equipment of a genuine botanist than it was in Eaton's time. This leads us naturally to some thoughts and propositions concerning the future of botany in America, and some lines of training necessary to make this future satisfactory. It will be readily admitted that aside from applied botany which has for its work the making known of the plant world for the greater comfort and enjoyment of the human race, one of the highest aims of purely scientific botanical study whether cytological, morphological, or embryological, is to determine the relationship of plants to each other and the establishment of a natural system of classification. This has been the struggle of botanists from the time of Jussieu to the present and every genuine botanical contribution attacking the problem continually from a new standpoint adds its iota to this desired end. The undergraduate course of botany therefore to attain its best success either as a preparation for life or as a preparation for botanical or biological research should not commence the fad for specialization too early. It ought thoroughly to familiarize the student with the common types of plants not alone in the laboratory and in pickle but in their living freshness in the field. The broadest as well as the most intimate acquaintance with as wide an array as possible is none too much. Besides the four hundred plants of the higher type that Eaton recommended as a minimum, the student of to-day ought to know half as many at least from the array of lower plants which in Eaton's time were a world almost unknown. And all this should be in hand in addition to the best attainable methods of study with the means of using to the best advantage the modern implements of research from the simple lens and the dissecting needles which should not be neglected, to the microtome and the various culture media. Following this, the research course for those who really expect to be botanists, to attain its highest results ought to involve some phase of systematic botany, for otherwise the student confining himself to too narrow lines is still in danger of losing his perspective. I do not mean systematic botany in its old-fashioned narrow sense but in its newer and broader sense in which morphology, embryology, and the widest application of accessory study in culture house, laboratory and field is brought to bear on the solution of a taxonomic problem.

The line of research study that is primarily embryological ought not to be confined to a single type, but should involve the comparative study of the types of a family or in the case of restricted families the relations to outliers in others. If the major line of research involves the life history of a species among the lower plants, it ought also to involve a comparative study of the allied American species, for no one could be better prepared to monograph a genus than one who from his studies of development understands the significance of morphological and structural characters, their degree of variation, and their cause. We have had enough of these studies of single things without bearings or relations, made by candidates for a degree whose botanical work is sure to end with the theses that they have been able to produce with the bolstering aid of their instructor, studies that mean nothing because the workers failed to grasp the real purpose of the study and its true relations and bearing on the general subject. It is too late to accept candidates for degrees in botany, who seek the degree as an ignominious end rather than a well-earned beginning and preparation for future work along botanical lines. Whatever we may be obliged to do with and for those who take undergraduate work in botany because they have to, we have no time for graduate triflers or any who are not intent on making botany their life work—who study botany not because it is a present fad or because they really think they have to study something, but because they are botanists born and must become botanists trained. Such will find their thesis the beginning of a series of researches instead of the swan song of a neophyte. In order to limit a wide subject more closely and continue our consideration of fields opening up to the trained botanical student, we may turn in particular to the field of work that lies open to the systematic botanist in America. For the higher plants I can do no better than to quote a recent remark of my successor in office, whose personal studies give to his opinion far greater weight than any words of mine, that there is scarcely a large genus represented in

America that is not in real need of revision, and surely the unparalleled activity of recent workers in this field not alone in the west and south, where novelties were more naturally to be expected, but even in New England and other parts of the Northeast, would seem fully to justify the assertion. Intelligent field study of which we need much more by trained botanists rather than by untrained field collectors is yielding its natural and legitimate fruit. And long before our ecologists can attain definite point to their labors we must know with far greater precision than now the definite limitation of the species of our higher flora.

When we turn to the lower plants we find a still more virgin field in which to sound the call for able workers; here not only is the need of revision real, but it is crying and in some cases almost shrieking in its need. Among the fungi the desultory description of species 'supposed to be new' must give way to careful revision, genus by genus and family by family. Field work and culture methods must supplement the most searching comparative study of the widest accessible array of material, and while it will certainly result in great reductions of species carelessly described by the older methods and in the correction of many errors of over-hasty reference of American species to those of European origin, it will also result in bringing to light many that by the same methods have been entirely overlooked. We could at once place twenty men carefully trained for research at work on as many groups of fungi in which our definite knowledge is only a hazy mass of crude and scattered bits of information needing to be brought into harmony with the results of careful consecutive comparative study. And beyond matter of the definite limitation of the species within the genus and the genus within the family, there are beyond and more far reaching in their scope the most important questions of alliances and origin of groups that demand the highest efforts of the most careful workers.

Among the Algæ the conditions are still worse, particularly among many fresh water forms, for here not only are our species in a haze of uncertain definition, but the very characters to be used in specific definition in many groups still remain to be formulated.

To accomplish this systematic study of our flora successfully will require the active co-operation of field botanists and special students. No longer can one man or a few men seek to realize the complete definition of even the higher flora much less the lower. There must be the most complete and candid co-operation on every hand. To this end we offer a few suggestions.

1. More and more the real systematic study of our flora must proceed from the centers where are gathered the stores of material and among these centers there ought to be the freest possible interchange of courtesies. Isolated workers in the field whose training is such that their judgment regarding specific limitation is worthy of respect, before attempting to publish their results should supplement their field and home study by an occasional year or at the very least frequent long vacations at some one of the centers where contact with books and types and still more with other workers and methods would correct their results and stimulate to better effort.

2. More and more the local field workers and amateurs should realize that as isolated facts are worthless until brought into harmony with some general law, so material illustrating the distribution and variation of certain plants is only valuable when deposited where it is accessible to botanical workers generally. Great collections are only good as well as great when the material they contain is accessible to those who are trained to study it, and local col-

lectors ought to realize that by freely supplying the material within their reach they confer a favor not so much to the particular center that receives it as upon all future workers in that field who look to that center as the proper repository of the material they need to carry on their researches. The most obscure field collector by concentration of observation rather than by diffusion of effort may add material that will be of vital importance to a correct and complete knowledge of our flora. More and more these field workers must be content to wait for results and not be clamorous for their material to be named by the next mail, resting assured that the material they contribute will receive due recognition on the final results and that none of their work that is really useful will go to waste; on the other hand the specialist taking his material in order will gain time for his final revision that would otherwise be badly broken up in miscellaneous examinations and too often marred by hasty determinations and conclusions.

The different attitude of people toward the botanist and toward certain of the scientific workers in fields where there is a much more decided commercial phase to the science, resulting in part from the fact that real botanists are such because they are first lovers of their subject, is well illustrated in this matter of the freedom with which material is sent to botanists for examination and report. Fancy a man sending to a well known chemist a half dozen samples of water for chemical analysis with the assurance that if any of the water is not used up in the process, the chemist may have it for his trouble!! And yet no one thinks of anything else in sending a botanist from a half dozen to two hundred specimens in a bale with the information that he would like them named and the specimens need not be returned. To do this correctly involves skill that requires fully as great an amount of scientific preparation and often more expenditure of time than to make a similar number of water analyses, yet to the botanist the idea of pay has not been presented. While it is true that by this self-sacrifice many of our great collections have been enriched with valuable material, and many solitary workers have been encouraged to better things, it is also true that it has been accomplished with an immense waste of time and nervous energy that ought not to be too lightly demanded of active workers. And this labor is all the more exasperating when some botanical worker who does not appreciate the necessity of abundance of good material brings in from some distant region merely a series of odds and ends of fragments that are yet sufficient to show that something really worth having might have been collected by a little expenditure of common sense and foresight on the part of the collector.

3. There are some practices rife even among those from whom we naturally expect better things which ought in some way to be put under the ban. I need only mention the practice of literary revisions of genera with no commensurate study or even knowledge of the plants themselves; the so called galvanic method of transferring species heterogeneously from one generic group to another except in definite monographic work; and the description of species in check-lists, fly-leaves, circulars, and other out-of-the-way places where they are not readily accessible to the general botanist. In short the closing years of the nineteenth century ought to sound the death knell of the literary enthusiast and the galvanizer and mark the disappearance of the grotesque and the rafinesque from American botany.

4. The extent of territory covered by the American Flora is on the eve of a remarkable expansion. The political events of the past few years are in part responsible for

this, but for years it has been evident that it was only a question of a little time when such expressions as 'a revision of the species north of Mexico' should be obsolete in American botany. The extensive explorations of Mexico and Central America by Anglo-Saxon American explorers have resulted in placing the flora of those countries in the hands of American botanists, and the Spanish War has had among its other results the transfer of the flora of the Antilles to the same hands. And with the extensive explorations that in recent years have been made by our botanists in South America, I fail to read the signs of the times correctly if they do not point to the ultimate inclusion of all the American continent from Alaska to the Straits of Magellan in the future of American systematic botany. Scarcely anything can be expected of our neighbors in the Central and South American States and many Europeans overlooking American work already accomplished or wilfully ignorant of it, are too often unsatisfactory in their results ; surely it is at once the privilege and the duty of the botanists of this country to take the initiative in a vastly more extended and systematically organized way than has ever been attempted and solve the most important problem that remains in the study of phyto-geography; the flora of the darkest of all dark continents—South America. Explorations on a stupendous scale, such as are necessary to attack this problem, can best be organized here in America where the accomplishment of great things is no longer a novelty. The English already realize that they have problems sufficient on their own hemisphere fully to engage their attention ; and it will not be long before our German friends will realize the same situation. It is most natural that Americans who are more familiar with conditions here and are more at home with the flora of the upper portions of the American continent, should be the ones to undertake this work and it is most certain that they will carry it out with greater accuracy because of their ability and proximity. I think it behooves the Americans practically to withdraw from any except the necessary comparative study of the flora of any part of the Eastern Hemisphere, and combine with such division of labor as will be practical and equable on the study of the flora of the American continent. In this way by example at least we can show our friends across the sea that in botany at least the Monroe doctrine is still a living and practical issue. I might add that those who are hoping for an international congress originating in Europe to settle questions of nomenclature, or any other line of botanical policy or procedure, entirely misunderstand the tenor of European methods, or the genius of European conservatism and inertia ; such as wait for a European congress to settle anything, will wait until their descendants of the third generation are tottering with age before such an adjustment will really occur. Americans must take the initiative in all these matters if they are ever to be settled, and the Old World must follow the lead of America in every field where progress is involved.

But all this extension of the study of our flora, even that which is limited to the North American continent, means years of study that cannot be accomplished on this side of the water. We are debtors to the Old World in that they found our continent and with that discovery took back to their own the memorials of their conquest. Not only are the great herbaria at Kew, at the British Museum, at Berlin, and at Paris the repositories of the types of many of the species of the American tropics but in these great collections are what are often more valuable than the types themselves, namely extensive suites of plants illustrating better than the type itself the range and variation and allies of the tropical species. To these greater collections we should add the lesser at Copenhagen, Geneva, Vienna, Prag, St. Petersburg and Madrid, all of which must be visited again and again before we can fully define even our North American tropical flora. To this end it will be in order to look to the establishment of traveling fellowships that will make possible continued study in those European storehouses by trained American specialists.

The time has come for American Botany to assert itself in the modest way that becomes Americans, and assume its true position in the work of botany in the world. We have the men who have profited from the training of the best the Old World could produce in morphological, physiological, and cytological work among plants; we have young men trained and in training who have the mental acumen of the best any country can produce, combined with a degree of practicality, vitality and energy of which very many of the Europeans are lacking; we have men of means who are philanthropic toward botanical research and stand willing to aid in every work that merits recognition, and if we in America do not in the next quarter of a century lead the world in matters botanical, it will be because we are not true to the instincts that guided the fathers in botany and because we do not enter into our heritage and magnify our opportunities.

Lucien M. Underwood.

Columbia University.

ARTIFICIAL PARTHENOGENESIS IN ANNELIDS (Chætopterus).

My experiments on the artificial parthenogenesis in sea-urchins have led me to the following results: (1) Through a certain increase in the osmotic pressure of the surrounding solution, the unfertilized eggs of some (probably all) Echinoderms can be caused to develop into normal blastulæ or plutei. (2) This increase in osmotic pressure can be produced by electrolytes as well as by non-conductors. It is therefore probable that the parthenogenetic development is caused by the egg losing a certain amount of water.*

I considered it necessary to try whether the same results can be obtained in other groups of animals by the same means. I have recently succeeded in producing artificial parthenogenesis not only in starfish (*Asterias*), but also in worms (*Chætopterus*). The experiments on the artificial parthenogenesis in Annelids led to the unexpected result, that the unfertilized eggs can be caused to develop into apparently normal larvæ (*Trochophores*) by two entirely different methods: First, by increasing the concentration of the surrounding solution (osmotic fertilization). This method is qualitatively the same as the one by which I produced plutei from the unfertilized eggs of Echinoderms. Second, by changing the constitution of the sea-water without raising its concentration (chemical fertilization). Through a slight increase in the amount of K-ions in the sea-water the eggs of *Chætopterus* can be caused not only to throw out the polar bodies as Mead had already observed, but also to reach the *Trochophore*-stage and swim about as actively as the larvæ originating from fertilized eggs. Further experiments showed that the K-ions have no such specific effect upon the unfertilized eggs of Echinoderms. This fact may help us to understand why a hybridization between worms and Echinoderms is impossible. I shall publish a full report of these experiments in one of the next numbers of *The American Journal of Physiology.*

Jacques Loeb.

Woods Holl, July 22, 1900.

* Loeb, J., *The American Journal of Physiology*, Vol. IV., August, 1900.

THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA.

II.

Photographs of Nebulæ and Star Clusters obtained with the Crossley Reflector: By J. E. Keeler.

The photographs on glass were exhibited by Professor Campbell, who called attention to some of the difficulties which had to be overcome in the use of the instrument and to the important results established, that nebulæ as a rule are spiral in form and as an exception irregular in form.

Some New Spectroscopic Binaries: By W. W. Campbell.

A list of half a dozen spectroscopic binary stars, recently discovered by Messrs. Campbell and Wright at the Lick Observatory. (To be published in the *Astrophysical Journal.*)

A Simple Method of inserting the Comparison Spectrum in Spectrographic Observations: By W. H. Wright. Read by Professor Campbell.

The length of the slit is limited by two total reflection prisms mounted immediately in front of the slit plate. The reflecting edges of the two prisms are parallel to each other and at right angles to the slit; and the distance between the reflecting edges is the length of the slit. The artificial light, from two sets of electrodes placed one near each end of the full-length slit, enters the slit through these prisms near their vertices. The method possesses many advantages. (To be published in the *Astrophysical Journal.*)

Color Screens as applied to Achromatic Telescopes: By George H. Peters.

Attention was called to the want of definition caused by the secondary spectrum in large refractors. It was then shown how this was removed at the U. S. Naval Observatory by adapting a cell filled with an absorbing solution between the eye-piece and eye of the observer in the 26-inch telescope. The thickness of the absorbing layer is about 6 mm., and the solutions used are the following:

1. Picric Acid and Chloride of Copper dissolved either in water or alcohol, for cutting out the red and blue light.
2. Picric Acid dissolved in alcohol or water.
3. Bichromate of Potash in water.
4. Chromate of Potash in water.

Solutions 2, 3 and 4 remove the blue and violet light. Alcohol is used in cold weather. The absorption of the liquids is tested by a direct vision spectroscope.

Some of the benefits derived from the color screen are:

Improved definition on planets and satellites and in certain classes of double stars.

In observations of objects by day where the blue light from the sky is removed.

Professor See and Mr. Peters are jointly credited with this device. (See *Astronomische Nachrichten*, No. 3636.)

The Spectrographic Determination of the Motions of the Stars in the Line of Sight: By W. W. Campbell.

Complying with the Council's request for a paper on this subject, the following points were presented:

The great interest taken in this problem is attested by the fact that the largest refracting telescopes in the United States, France, England, Germany, Russia and Africa are, or soon will be, largely devoted to the determination of stellar velocities.

It must not be assumed that, because a 36-inch objective receives nine times as much light as a 12-inch, it will be able to carry velocity determinations in that ratio to the fainter stars. The larger telescope is accompanied by stronger absorption of the light, by larger stellar images (except in perfect seeing), by greater difficulties in guiding, etc.; so that it is able to extend the work of a 12-inch telescope only 5- to 7-fold. A 36-inch reflector, suitably mounted, and in a dry climate, would probably be more efficient than a 36-inch refractor in this problem.

Success in determining stellar velocities depends upon a great many elements, of which the following were all that time permitted a mention.

I. A suitable compromise between the various optical and mechanical features—many of which conflict—to secure a powerful and efficient spectrograph.

II. Suitable prisms and lenses. The requirements demanded by the line of sight tests are so severe that satisfactory lenses and prisms are difficult to obtain. Since a change to a new prism-train usually requires many changes in the mounting, the prisms should be constructed and thoroughly tested before the rest of the instrument is designed.

The day for using the ordinary double camera lens is past. Even the triple lenses do not fulfill the difficult spectrograph's requirements.

III. Absence of differential flexure during the exposure time: the optical angles must remain constant. This is very largely a problem in mechanical design. The elimination of appreciable flexure effects during long exposures is difficult, but not impossible. Existing spectrographs, including those just now completed, are wrongly designed, in that they are supported only at one end. The heavy prism-end projects out into space, unsupported. The spectrograph is held out 'at arm's length,' so to speak. Now the spectrograph is an instrument complete in itself, and need not be rigidly connected with the telescope tube. A framework connected with the telescope could be arranged to support the spectrograph, in position, both near its upper and its lower ends; care being taken that strains in the supporting framework should not be communicated to the spectrograph. This form of support would permit a more economical distribution of material in the spectrograph, and should decrease the flexure effects several fold.

IV. The Mill's spectrograph has been enclosed in a wooden box case, lined with thick hair felt, carrying on its interior surface about 30 feet of German silver wire. As the temperature within the case falls, a storage battery is connected with the resistance wire. The heat generated tends to keep the instrument, and especially the prisms, at a constant temperature—a most important desideratum.

V. An accurate method of guiding during the exposure.

VI. The use of the finer dark lines throughout the spectrum, rather than of the heavier lines which have heretofore been the ones measured.

VII. Long experience in making the measures.

An exposure of one hour is required for a star of the 5th photographic magnitude, as given in the Draper Catalogue.

At the Lick Observatory two or more plates have been secured for each of about 300 stars. For the best stars, such as *Polaris*, the probable error of a single determination of velocity is about one-third of a kilometer per second. For such stars the plates seem to be essentially perfect, and to secure greater accuracy it appears that a more powerful spectrograph is required.

Even with perfect plates the observer must be on his guard against systematic errors arising from changes in his personal habit of measurement.

Of the 300 stars observed, 22 have been found at the Lick Observatory to be binary, in addition to three previously detected from the same list by Belopolsky. This leads us to the important conclusion that one star in twelve is a spectroscopic binary. And it is probable that others of the stars observed are binaries as yet undetected.

Some Peculiarities in the Radial Velocities of ξ Geminorum: By W. W. CAMPBELL.

This is a well known variable star, period of $10\frac{1}{6}$ days. Its velocity in the line of sight was found, independently at Pulkowa and Mt. Hamilton, to be variable. Forty-five observations at Mt. Hamilton, distributed over $1\frac{1}{2}$ years, left no doubt that this star is a spectroscopic binary, and that the variation in brightness is produced by the companion. The eclipse theory is untenable. The variation is probably the result of tidal action between the two bodies.

The observed velocities cannot be represented by elliptic motion. Drawing the elliptic curve which best represents the observations, the observed curve is alternately above and below it, crossing it at intervals of about 41 hours. Three complete periods of the minor irregularities coincide with one light period. These minor irregularities in the observed velocities are probably due to minor tidal effects in the star's atmosphere. (To be published in the *Astrophysical Journal*).

H. M. Paul. I would like to ask if these observations were plotted to represent the total amount of observations, obtaining the period from these observations.

Mr. Campbell. They were all plotted with reference to the brightness of the star assuming the old period. There is some doubt as to the exact form of the light-curve. I have endeavored in every possible way to ascertain the form of the light-curve; but there seem to be some irregularities, and I think that extremely accurate observations would show that the brightness curve has the same irregularities as the velocity curve; that there is a reflex action of one upon the other.

G. W. Hough. Were there any systematic observations to ascertain the cause of irregularities with reference to motion in the line of sight?

Mr. Campbell. No; we have obtained our results merely as by-products from the system of guiding that we have employed; and we have made changes in the system of guiding in the expectation that if we could eliminate the difficulties arising from that, so as to make it satisfactory for one bright star, it would be satisfactory for two stars.

Mr. L. E. Jewell. Mr. Campbell has suggested that the irregularity in the motion in the line of sight may be due to tidal action, which I think is probably the case; but he has also suggested that it may be due to tidal compression, which I do not think can explain the phenomenon. I have myself been engaged in some work bearing upon that problem, and among other things the pressure of the different layers of the solar atmosphere; but the lines which have been measured in the solar atmosphere do not have a pressure of more than $1\frac{1}{2}$ atmospheres, considering the pressure of the earth's atmosphere as one. The variation due to difference of pressure would be too slight to produce the effect that he speaks of. I think it probable some tidal action causes the motion in the line of sight, and that it is not due to change of pressure, because the differences of pressure would be too slight to produce such an effect. In the case of the sodium lines in the sun's atmosphere, the actual pressure is only about an atmosphere and a quarter. The variation in the hydrogen lines would be very small, and it is probably produced in a higher layer of the sun's atmosphere.

Mr. Campbell. We seem to have no analogous case to this star from which to obtain data to explain it. We have no knowledge of tidal action elsewhere, but here we seem to have enormous evidence of tidal action.

T. J. J. See. I think the explanation of the cause of the second curve superposed upon the first curve is very probable. In the case of the ocean tides, we have very little vertical motion and a horizontal motion many times greater. The distortion shown in the figure indicates that the horizontal motion is very large.

W. J. Humphreys. Some work has been done by Wilssing at the Potsdam observatory, showing a great change from change of pressure; but he applies this to such stars as Nova Aurigae. He has obtained results, working with hydrogen, showing that the spectrum lines in hydrogen are very sensitive to diminution of pressure. This applies especially to the deeper lines. He has obtained perfectly sharp lines with a pressure of 14 atmospheres.

Mr. Jewell. From our knowledge of the solar spectrum it is perfectly certain that the lines do not show any evidence of powerful pressure. Under such pressure the lines would probably be broader.

The Indian Eclipse Photographs of Jan. 22, 1898, obtained by the Lick Observatory Expedition : By W. W. Campbell.

Photographs of the corona and its spectrum; and of the spectrum of the sun's edge, were thrown on the screen. Special attention was called to the apparent and probable connection between the prominences and the curved coronal streamers enclosing them and to the relative displacement of the bright and dark lines in the spectrum of the sun's edge.

Total Solar Eclipse of May 28, 1900.

Simon Newcomb presented the report of the committee upon the observations of the recent eclipse.

W. W. Campbell. Being a long distance from our base in California, it was impossible to take our plates home for development, and they were developed in camp, where it was impossible to do photographic work successfully. I have brought one of the original negatives, but Mr. Brown should have the privilege of presenting it. It was taken with an exposure of one second, with a 40-foot camera. It reveals the fact that the coronal tails were not so numerous as those in 1898, while those were not so numerous as in 1893. There seems at first to be no connection between the coronal streamers and the prominences; and yet, if you will go over the plate carefully, I think you will see there is some connection between them. Our spectroscopic material was not so great as we should have liked to obtain; but for the third contact we obtained very satisfactory results. It was a question whether bright lines would be shifted towards the red end, but they seem to show no evidence of such shifting.

S. J. Brown. The eclipse observations of the Naval Observatory were widely distributed and covered a great deal of ground. Two main stations were occupied, one in North Carolina and the other in Georgia. Our photographic work is not in a condition to exhibit. There was one experimental line of research I think it worth while to mention. We wished to try experiments with color screens; and with one lens we used isochromatic plates, and with another lens the ordinary photographic plates, to see whether any indications would be shown as to a difference of structure of the corona due to the green line. The result showed no difference of structure, but there seems to have been a greater expansion of the polar rays when we used the color screens than when we used the ordinary plates. Photographs were taken to obtain as great an extension of the corona as possible; but the sky was not favorable, and we did not obtain so great an extension as was shown by the results in India. The spectroscopic work occupied our most serious attention. We had some very rare gratings, ruled to concentrate the light of the first order at a special point. Two of these gratings, from the Johns Hopkins University, were utilized, one at Pinehurst and one at Griffin, besides another grating of long focal length. Our preparations for this work were much hurried, but we had gratings of which the curves were carefully computed for the focal length of the quartz lenses. At Griffin we obtained a reversing layer of eight seconds. Mr. Jewell has brought some copies of the only successful plates at Pinehurst, showing several new coronal lines, one coinciding with the 1474 lines, and there were three other new lines. Dr. Dorsey of the Johns Hopkins University also took photographs, and Dr. Wood of the University of Wisconsin undertook to study the shadow bands which precede and follow the eclipse. He is not here, but he thinks he has reached a satisfactory conclusion with regard to the cause of the shadow bands. While our results in spectroscopic work were disappointing, in view of the large outlay, they seem to vindicate the value of that method. We think we shall be able to obtain a plate which will bend to the required curvature, and thus be able to photograph the reversing layer.

L. E. Jewell. We obtained a different wave length for the bright and for the corresponding dark lines ; and I think that difference in wave length is caused by the fact that the dark lines were produced very close to the moon's edge, by the remaining portion of the crescent, not covered by the moon, while the bright lines were produced further out. On one of the photographs taken at Pinehurst there is a very distinct difference of the *H* and *K* lines, between the bright and dark portions of the spectrum. The bright line is displaced with reference to the dark line in the direction outside, or further away, from the sun itself, just as it should be if that were the true explanation. In determining the method we should follow in the use of these plates we were largely influenced by the results of Evershed in India in 1898, showing that the chromosphere and reversing layer were much brighter in the upper part, showing other interesting phenomena. Another interesting thing was the presence of the rare element scandium. It was thought best to use his grating for the purpose of our work, and I made comparisons showing that he used a dispersion about three times that of a single prism ; and we concluded that we could obtain at least as much light from our grating as from a prism. Our results at Pinehurst were thought of extreme importance. With an exposure of only one second we obtained results showing that if we had been able to bend the plate to the required focal length, it would have given us a spectrum from wave length 30 to 60, giving us 1300 lines ; the effect being very sharp lines in the neighborhood of the *H* and *K* calcium lines, and pictures of the chromosphere proper and the reversing layer showing 50 to 75 prominences. The difference between the calcium and the hydrogen lines was shown very prominently indeed. A plate out of focus showed the yellow sodium line, and the coronal lines at 1474 which were seen much stronger on the opposite side of the sun from that where the ordinary bright lines are seen. This green line was much brighter than on the western side of the sun. There is no line which seems to be evenly distributed on the two sides of the sun. The green line seems to be gathered into a very short arc on the western limb. On another plate taken 25 seconds later, the exposure was 5 or 6 seconds, and on that these coronal lines are shown all the way round. There are four lines not obtained before, the substance producing them seeming to be about the same as that giving the green lines. They show the strongest at some distance from the sun's surface, say three to five thousand miles above the solar surface, although they are visible close to the solar surface. Another interesting thing was the beautiful way in which the carbon band showed with an exposure of one second. It was very strong a hundred miles from the solar surface. One word with reference to future work: I think it is very desirable to use a concave grating in the ordinary way, but instead of using a dense lens of quartz, to use a very large concave reflector of a focal length of 100 to 150 inches, which would give an image of the sun an inch and a half in diameter; and then we could use a wide open slit so as to be certain to get the limb of the sun inside of it. At Pinehurst we had to cut down the slit in consequence of the curvature, and had an image of the sun only a third of an inch in diameter to work with. In future work much the best plan will be to use two concave mirrors, one of a short focus for the dense lines, and the other of a considerable focal length, the slit being placed between them. In this way we can let the light come through the narrow slit, and then the larger and long focus mirror will act as a condenser, and there will be no disturbance whatever in the focus. A telescope of high power should be used, and focused very carefully; and the light reflected from the second mirror would give us parallel light; and if the adjustments were well made the image would be very sharp. By that method we ought to be able to obtain very satisfactory results.

Winslow Upton. I will report briefly the work we did near Norfolk by very ordinary astronomical and photographic processes. We had a four-inch telescope for visual work; and we had an equatorial stand upon which a camera was carried by clockwork. The camera contained two very long focus lenses. We also had four ordinary cameras, which we used for the purpose of obtaining the extension of the corona. We found that the duration of the eclipse was shorter than calculated. By the English and the American Ephemeris it was 101 seconds, while we made it 99 seconds. In the visual observations we used a magnifying power of 50 or 60. At the time I did not notice the hooded arrangement of the corona, this gigantic hood overlapping the strata, shown in the photographs of the eclipse of 1878. In our observations to determine the place of the moon, and in the search for an intra-Mercurial planet, we carried out the instructions of Professor Pickering, which were to expose for 60 seconds. Our cameras covered a range about 25° along the sun's equator, and with 8 or 10 gigantic plates we covered that region; but we got nothing except one or two bright objects, possibly only the planet Mercury, and there seemed to be star trails instead of images, perhaps from a fourth magnitude star. I think the exposure might have been longer; for I feel confident that we could have exposed 80 or 90 seconds without fogging the plate. For the spectroscopic work we used triple-coated plates, especially made for us by the Seed Co., and also orthochromatic plates. With regard to the development of the plates we decided to vary from the instructions of the Committee. The instructions were that we should use an exceedingly weak developer and develop a long time. Professor Pickering on the other hand recommended a strong developer, and a great deal of bromide. As we had duplicate plates we decided to try both plans, and I think on the whole that we obtained better lines with the strong developer and the bromide restrainer. I have here some lantern slides which I will show.

Ormond Stone. The University of Virginia took part in the eclipse observations at Waynesborough, N. C. We used a 40-foot camera. I desire here to express my gratitude to Professor Campbell for the advice he gave us at the beginning, and for his kindness in assisting in the preparations, and also in developing our plates for us. Our preparations were begun very early and we went to the camp about a month before the eclipse took place. At the time of the eclipse the sky was perfectly clear, and we took a very good series ef pictures, showing a vast amount of detail clear down to the sun. We have learned much of what ought to be done in the future. Eclipse problems are constantly changing and new methods are used. In the adjustment of the frame in position, I think it ought to be done by actual observation of the stars, rather than by experiment. We happened to get our carriage some inches out of place, but by our observations we brought it within 1–16th of an inch of its true place. We may study the photographs as to the forms of the filaments, and the relations of the chromosphere to the protuberances; but that ought to be supplemented by visual observations with the telescope. A six-inch telescope with a magnifying power of 50 will show us ten times as much as can be seen in the best photographs. But the observer sees it and no one else, so that we still need the photographs. The plates were exposed by Mr. Mayo, who had himself constructed the apparatus. Mr. Morgan had a four-inch equatorial, and I used a six-inch equatorial and observed visually. It was our purpose to examine each of the prominences in succession to see if we could perceive any distortion. We could see no relation to the protuberances, and our visual observations simply confirmed what was shown in the photographs. At the eclipse of 1878 the filaments were well seen, and each one stood out distinctly. At this eclipse there was not that sharpness, and there seemed to be a strong background of something else to the equatorial filaments. In 1878 at the poles the rays were very much as in this eclipse. In the equatorial region there was a perfect network of filaments. They started out and moved right back with an incurvature in the opposite direction, so that there were a number of filaments side by side. They are certainly not hyperbolic curves, but we do not know what they are. One suggestion is that they are meteoric or comet streams. Our exposures were mostly short; we had nothing exceeding 12 seconds. It would seem well to have some longer exposures. I am glad the Naval Observatory has secured a plate with a longer exposure, on which we can see longer filaments and learn more of the nature of the curve. By tracing the curve back to the sun's surface we may be able to get some idea of its form. We had a number of small cameras mounted on a polar axis and managed by Mr. Lyon, and with these we used a color screen such that the green line was not seen, but on an open space. I think in another eclipse we ought to get more color screen pictures with our large cameras.

Mr. C. C. Abbott presented a report of observations at Waynesborough.

Mr. Dorsey explained the mode of determining the polarization of the bright coronal lines.

The Secretary read the following reports from Edwin A. Frost and E. E. Barnard upon their observations of the eclipse made at Wadesboro, N. C.

E. B. Frost. Four spectroscopes were employed: 1. A small plane grating in front of a lens of 2-inch aperture and 20-inch focus, for visual use in determining proper instant for exposure for obtaining 'flash' spectra.

2. Train of 3 large flint prisms, at minimum deviation for λ 4230, in front of photographic lens of $3\frac{1}{2}$-inch aperture and 42-inch focus; for photographing flashes and cusps and coronal spectra.

3. Small concave grating used directly, without slit; focus 30-inch for photographing flash spectra.

4. Large plane grating of 20,000 lines to inch, in front of visual lens of $3\frac{1}{2}$-inch aperture, 42-inch focus, with red screen, for photographing red end of spectrum of cusps, flash and corona. All placed in horizontal beam 13-inch diameter reflected from

cœlostat. Time called by Professor A. S. Flint; exposure of 2 and 3 operated by Dr. G. S. Isham of Chicago; signal for exposure given by visual observation of flash with 1 by E. B. F., who operated 4.

Results: 1. The flash spectrum was visually observed in the yellow near D_3 at second and third contacts. The number of lines seen, however, was not as large as might have been expected; some 12 or 15 were seen in the small field employed. These were broken by the prominences, and were doubtless chiefly lines of the usual chromospheric spectrum. No attempts at measurements were made, as the object of the visual observations was to find the instant for making the exposures for flash spectra. The dark lines of the cusp spectrum were sharp and distinct 45 seconds before the computed time of totality. A glance into the eyepiece at the middle of totality showed no coronal rings in the field, which did not include the region of 1474 K.

2. Objective train of three large prisms (mean path of the rays in the glass was 8 inches). Five exposures were made, on two plates, all of which were successful.

(*a*) The two spectra of the cusps, taken before and after totality, show many bright (chromospheric) lines in addition to the dark lines. The region covered by the plate was necessarily limited, by the construction of the plate holder, and includes only from λ 4380 to λ 4025. Fifty bright lines were measured on the second cusp spectrum.

(*b*) The first flash spectrum shows no continuous spectrum, but will furnish the wave-length of many bright lines. Something over 100 lines appear to be measurable within the above limits.

The second flash spectrum was overlaid by a band of solar spectrum, the third contact occurring some seven seconds earlier than was expected and indicated by the count. This plate, however, shows a large number of bright lines, 275 having been measured on it by the writer between λ 4380 and λ 4027. Young's list of chromospheric lines contains 27 in that region.

(*c*) The coronal exposure was of 30 seconds, but could have been longer to advantage. The rings of $H\gamma$ and $H\delta$ (chromospheric) are strongly impressed, showing the prominences, and next in intensity is the strong chromospheric rings of wave-length λ 4078. Four other rings are seen in whole or in part, the coronal ring at λ 4231 being next in intensity, although faint. It shows none of the broken appearance which characterizes the chromospheric rings. Another ring of longer wave-length than the $H\gamma$ may also prove to be coronal. The continuous spectrum of the corona is quite strong. This plate has not yet been accurately measured.

3. The small concave grating, without slit, was used for first and second flash.

On the first some 70 lines (bright) are shown between $H\beta$ and $H\delta$; on the second about 110 in that region, with about 50 others less sharply in focus, chiefly on the violet side of $H\delta$.

4. With the limited time for exposure, the sensitiveness of the plates, of the 'Erythro' brand was insufficient to record the flash spectra. The plate exposed for 60^s to the corona shows no impression, as was indeed expected. The spectrum of the cusp ten seconds after totality shows some dark lines and a few bright lines, and the second flash spectrum is seen in traces.

E. E. Barnard. The following preliminary statement concerns the photographs of the corona obtained by the Yerkes Observatory expedition to observe the total eclipse of the sun at Wadesboro', North Carolina, May 28, 1900.

The weather conditions were as near perfect as possible.

The most important instrument was a 61½-foot horizontal cœlostat with an excellent 6-inch photographic objective made specially for the purpose by Brashear. The light was thrown into the telescope by a very perfect plane silvered mirror made by Mr. Ritchey for the instrument. The equatorial mounting that carried this mirror was also made under Mr. Ritchey's direction though not for this special purpose. It was, hower, adapted by him for a 48-hour revolution. This instrument was driven by the clock from Professor Hale's 12-inch equatorial. The mounting also carried a 15-inch mirror for Professor Frost's spectroscopic work.

A long horizontal tube connected the 6-inch objective with the photographic house. This tube consisted of a wooden frame work covered with red water proof paper and was whitewashed on the upper part. A white cloth covering was also placed over it with a few inches of air space between the cloth and the tube. Frequent diaphragms were put along the inside of the tube to prevent stray light or reflections.

The photographic house in which the plates were to be exposed, was about 30 feet by 6 feet; it was of wood made thoroughly light proof by heavy red paper.

The plates were placed in a carrier 15 feet long, which ran on ball bearings in a light-tight sheath—the exposures being made through an aperture in the sheath where the image fell.

With this carrier, by rapidly shoving it along, one plate after another could be substituted for exposure with the minimum loss of time, about four seconds for a change. With it seven plates were exposed. Three of these were 14x17 inches, and the other four 25x30 inches. The following exposures were given these plates.

No.	Exposure.	Size of plate.	Kind of plate.
1	$\frac{1}{2}^s$	14 x 17	Cramer double-coated.
2	2	14 x 17	Cramer 'crown.'
3	8	25 x 30	" "
4	30	25 x 30	" "
5	14	25 x 30	" "
6	4	25 x 30	" "
7	1	14 x 17	Cramer double-coated.

A stop, regulated by hand, fixed the position of the carrier at each exposure, so that the image should always fall central on the plate. The plates were all set parallel to the celestial equator.

The exposures were made by a wooden exposing shutter, with a round aperture on one end of it. This shutter was controlled by two cords, one from each end, running into the photographic house. These cords being held taut, one in each hand, the exposures were made with absolute certainty and rapidity, by a quick pull with one or the other hand.

In the actual work, the carrier containing the plates was moved forwards by Mr. Ritchey after each exposure. At his signal 'ready' the proper exposure was given by me, the time being counted from a sounder beating seconds.

The seven plates were exposed without a hitch, the program being successfully carried out.

The signal for the beginning of totality was given by Mr. Putnam of the U. S. Coast Survey, who observed the contacts with a telescope at the Smithsonian Station, a hundred feet or so distant.

The exposures were begun immediately upon the signal for totality. A signal was also to be given ten seconds before the close of totality. This last signal was heard while preparing for the last exposure, and certainly within three or four seconds of this the exposure was made; the sun was then just appearing as a small speck of light—the end of totality having apparently come sooner than was expected.

At each exposure the image was seen on the plate and I was at once impressed with the striking likeness it bore to the corona of January 1, 1889. Though the moon appeared very black on the plates, the corona itself was disappointingly feeble. In the casual inspection, during exposure, the prominences were not noticed and but little detail was visible.

On the night before the eclipse each plate had been carefully backed with a non-halation solution consisting of caramel and burnt sienna. The plates were at once placed in the carrier ready for exposure.

In preparing for the eclipse the question of sensitiveness of the plates to be used was carefully discussed with Professor Hale and we finally decided to use the most sensitive plates. The result justifies our decision and shows that with a long focus instrument like this ($\frac{1}{123}$) the plates cannot be too sensitive.

Two of the plates were Cramer double-coated and were supposed not to be so sensitive as the Cramer 'Crown.' Plate No. 1 (double-coated) was purposely left unbacked. No. 7 was also double-coated and backed.

Up to this writing, plates No. 2, 5, 6 and 7 have been developed. They are remarkably sharp and perfectly defined, and show the prominences and inner corona very beautifully. The polar fans come out magnificently. There is a great deal of beautiful detail in the inner corona that promises to richly repay careful study.

Great care is being exercised in the development of the plates to insure not only detail near the sun but to get also as great extension as possible.

Other instruments used were a 6-inch and a $3\frac{1}{2}$-inch portrait lens, mounted on the equatorial mounting formerly owned by Mr. Burnham and kindly loaned by Professor Comstock.

A $4\frac{1}{2}$-inch Brashear portrait lens, and a very sharp focus (1:1.9). Voightlander lens of 4 inches aperture, were strapped to a fixed post and were used for quick exposures on the corona. Three Sonader lenses, kindly loaned by Mr. Ellerman, were placed on a small heliostat mounting and were given an exposure extending nearly through totality, with three different kinds of plates.

The plates with the small instrument have, in part, been developed. The results show an extension of the corona between 3 and 4 diameters of the moon. The corona, as shown on these plates, is singularly like that of January 1, 1889. There is a broad fish-tailed extension spreading out to the west more than half way to the planet Mercury, which shows on all the plates. A long, thick set, more or less pointed mass, extends to the east for several diameters of the moon. The poles are surmounted with fan-like systems of rays—the whole entirely characteristic of the sunspot minimum corona.

The results with the cœlostat show that it is by far the simplest and best instrument for securing photographs of the corona on a large scale. The results also show that the images could be made very much longer with much gain. An instrument of this kind for photographing the corona could safely be made several hundred feet in length with a corresponding increase of aperture.

G. A. Hill. A few remarks with regard to the observations especially made to determine the position of the moon. In several of the reports the idea is presented that the time predicted from the ephemeris was not accurate. This I think was caused by the position of the observer and his station not being exactly known. At Lawrenceville we had a transit telescope, and we computed the times of contact. The times of the second and third contact agreed within 0.5 second with the ephemeris, and the times of the first and last contact came within 1.9 second. The duration of the totality was exactly given from the ephemeris. At Barnesville we had a clock giving seconds, with the 60th second left out, and the gentleman who took the time there lost his count, omitting that second, so that we were a second late in our time. But this was not the fault of the ephemeris, but of the man who counted on the clock. I was much gratified with the condition of the sun on the morning of the eclipse. The sun was unusually steady, and we succeeded in obtaining contacts that were quite satisfactory.

M. B. Snyder. I would like to call attention to the prominence on the southwest corner of one of the plates. I observed it visually, and was puzzled by the peculiar extension of that prominence. There was a decided change in its character. At the top there was a gradual fading of the prominence and the corona; and this is brought out by the photographs shown.

Ormond Stone. In the observation of contacts it seems to me that there is a different way from the usual way, and which is preferable to it. The method used by myself in the eclipse of 1878 was used by Mr. Morgan at the present eclipse, at my station. I am not aware that it has been used elsewhere. It gets rid of the difficulty which arises from the fact that, especially at the first contact, we recognize the contact by an indentation. In other words, we do not observe the first contact at all, but we recognize as the first contact a time which is not the first contact. The method which we used was this: A divided scale was placed in the field of the telescope, with 20 divisions on each side, with every fifth division a little longer. This was placed at the proper angle to correspond with the diurnal motion, and carefully focused. When the indentation in the sun's edge had the length of one division a record was made; when it had reached the length of two divisions another record was made and so on through. By examining the report of the eclipse of 1878 you will see how closely the different results agreed. The observations of the present eclipse have not been reduced, but it seems to me that some such method as I have described is far preferable to the method of noting the time when the indentation is large enough to be fairly visible.

Edgar Frisby. The observation of the first contact involves the knowledge of about the position where the contact will occur. Of course it is always a little late, but when the observer knows the position and is looking very closely, the error must be very small. We should expect the last contact to be very close; but I have found, from the experience of three or four observers, that the agreement was not so close as in the first contact. It seems after all to be more difficult to note the exact time of the last contact than of the first.

A Member. With reference to the remarks of Professor Upton, I may say that I had charge of the camera, attached to which was a visual telescope so that we should be able to know just when to get the flashes. The time of the first flash was successful, and I made the exposure and got a number of bright lines. The second exposure was made after about ten seconds, during the totality, and it partially showed the bright lines. The chromospheric rings were not well shown because we had no driving clock. The attempt to get the flash at the last contact was not successful in consequence of the shortening of the time of exposure. After this I made an exposure of 10 seconds every minute, and several plates showed a continuous spectrum. One minute after the third contact the lines were beautifully shown. The cause of the apparent continuous spectrum was perhaps the fact that the background was not sufficiently bright to show dark lines. Possibly they were all there but not thoroughly brought out.

M. B. Snyder. You will remember that a year ago I called attention to the use of the phonograph as a means of recording the time. During this eclipse I have actually tried the phonograph, with results quite satisfactory. We concluded that we might observe the shadow bands, and erecting a screen directly opposite to the sun we observed these bands and recorded the results by the phonograph. In this I was assisted by Mr. Thompson.

Mr. Thompson. At Mr. Snyder's request I will say that having gone to observe the eclipse, I undertook in co-operation with him to watch for the shadow bands. I stood about 20 feet away, and about three minutes before the sun disappeared I noticed very faint streaks. I did not communicate this to Mr. Snyder until they became unmistakable. At that time they were moving, so far as could be determined, at about the rate of a man running, say, 20 or 30 feet per second or perhaps faster than that. The points were curved, and they appeared to be broken into little curves 4 or 5 inches apart. I should think the dark places increased in width as totality approached until the darkness seemed to cover the entire space, and a few seconds before the totality everything had gone into confusion, and there was no definite progress after that. Just after the totality I noticed that the same direction as before was maintained, but that there was another system of bands moving in the opposite direction. Thus there were two sets of bands moving in opposite directions, for a very short time, of which Mr. Snyder has the record in the phonograph. Those that moved in the original direction persisted, fading out gradually in about the same time they took to come on before totality. I think it very likely that the confusion which I noticed just before totality was due to the action of the two systems of bands.

Brown Ayers. As I have never figured in the scientific world as an astronomer, it may have been presumptuous for me to undertake to do so much as I did in the observation of the eclipse. But I realized that my position at New Orleans was near the center of the totality, and there were parties who came to our place to observe the eclipse, but who located on other grounds. The location seemed to be poor, and one or two who thought of coming gave it up. But I thought as we were the only institution of any magnitude on the line of the eclipse it would be absurd if we should allow it to pass without any observation whatever. When we received the little ephemeris sent out by the United States Naval Observatory, we laid our plans as to what we could do with the appliances at hand. The result was that I tried to observe the shadow bands, and to get the contacts as well as possible. That was my program until about ten days before the time of the eclipse; when Chancellor Fullerton of the University of Mississippi, wrote and offered to loan me a fine telescope of 15-inch visual and 9-inch photographic aperture, made by Grubb. I received it gladly, and mounting it prepared to take some photographs with as much accuracy as I could. But the main point I had in view was to get the times of contact. There were different points in the city carefully determined and marked by the Coast Survey, so that I was able to get my position accurately, and I could get Washington time by signals in my observatory. I was able to make a very large number of comparisons to obtain the local time. The plan I adopted was a combination of visual and photographic work. We took the pictures as rapidly as we could feed the plates into the telescope, the position being carefully adjusted by star-trails, and we had a snap shutter automatically recording the time at which each picture was taken. This gave us a large number of photographs of which the time was accurately determined. We were so fortunate as to get a plate showing the Bailly beads, and the next plate was blank; so that we have secured a very accurate observation of the time of the second contact. At the time of the third contact I was peculiarly fortunate; for just as the plate was exposed by the snap shot, there was a sudden flash, and I think I have the time of that contact photographed pretty closely. In addition to my work, Professor Fullerton, who was within a few feet of my observatory, made visual observations ; and I think we can work up some successful results. Instead of the collection of astronomers they had at Waynesborough, we enjoyed isolation, and the eclipse was an old story with us before they could do anything in Georgia or North Carolina. There was one little thing I should like to note, to which my attention was called by Mr. Brashear. It is that one large prominence which on my plates is distinctly turned over, half an hour later in Georgia was standing straight up. This shows the change which had taken place after my observations at New Orleans. We had beautiful weather until the eclipse was over, when it immediately clouded up. We took over 50 photographs; and although we had no astronomers with us, unless we count Professor Fullerton as one, I think we did our best.

Winslow Upton presented a report of shadow bands observed by John Ritchie Jr. of Boston, and also those observed by Edwin F. Sawyer.

W. J. Humphreys. Mr. Ayers states that just as the exposure closed, at the second contact, he looked up and saw the last of the sunlight go; that the totality had not quite begun when this exposure was made. The plates shows not only no dark line spectrum at all, but there were bright lines. This seems to show a very remarkable phenomenon. At the second and third contacts there was a slight depth of solar photosphere and a great deal of halation; but immediately after the third contact there is no halation whatever, and the lines are extremely bright, showing the crescent due to the plate and the chromosphere. I noticed something that seemed to be of the same character. It was $2\frac{1}{2}$ to 3 minutes before the second contact. I was observing with a telescope made up of a field glass and a small reflector, using no slit, and when I began observing I saw the narrow crescent of the sun as a dark crescent in the spectroscope. The form of the lines, instead of being straight, was crescent. Then the bright lines began to encroach upon the dark crescent, and the dark crescent began to shorten and broke up into a number of short crescents, and these came down to a narrow line, not a dark line but a bright line, which continued for nearly a second and then suddenly disappeared, when the whole field was filled with bright lines. The F line, at the time of totality, extended around almost the complete circle, perhaps three-quarters of the way round, and at that time there were only a few other lines observable. The magnesium lines showed somewhat. One thing I wish to call attention to is that the photograph shows that at the second exposure there were only bright lines and no dark lines at all. Mr. Gilbert was under the impression that the photosphere had not quite gone. The base of the chromosphere was intensely bright, and this is required for the reversal of the small lines which are produced very close to the photosphere. I also call attention to the fact that where the spectrum was almost continuous there was a very decided difference between the brightness of the bright lines and the dark lines. Very many of the dark lines were reversed, and there was no such phenomenon connected with the bright lines.

W. W. Campbell. This layer which is spoken of is shown in one photograph which was taken before the totality was ended, absolutely that and nothing else, and it extends over 150° on the western side of the sun. Another point that I wish to emphasize is our appreciation of the kindness of the Weather Bureau in sending us bulletins. The Weather Bureau observations showed that a strip of territory in western Georgia and in eastern Alabama, had the best chance of securing observations of the eclipse. But in fact I think we had the poorest weather. A minute after the eclipse was over the sun was thickly clouded over, a large mass of clouds coming up from the west. In connection with this I will say that a member of our party made it a part of his business to observe the corona, and he found that he could visually observe the corona 70 seconds after the eclipse was over. We thought it was not worth while to take photographs at that time, but we could probably have followed the corona longer except for the clouds which came up and covered the sky at that time. With regard to the green ring in 1898, which was shown very much broken up, indicating great coronal activity there, in this eclipse we had the green material piled up in large masses.

A Member. I was watching the region of *F*, to learn how to keep the image in the slit. It was not a gradual nor a sudden change, but a flickering one; and it went out a number of seconds after the totality in exactly the same manner that it came in, so far as its brightness was concerned. I am sure that if the best arrangements were made to economize the light, a grating of $21\frac{1}{2}$ inches focal length could be successfully used. The light from that part of the sun which was upon the slit was not more than 1/200th part of that thrown by the cœlostat upon the ruled portion of the grating. If we could in some way economize the slit we might get good results from it.

Mr. Jewell. Probably the flickering spoken of was due to a slight tremulousness of the atmosphere. An interesting thing to observe was the carbon bands, which were exceedingly bright at a distance of 100 or 200 miles above the sun's surface, and which extended out about 400 miles.

OBSERVATIONS OF EROS AT THE COMING OPPOSITION.

Simon Newcomb. Some one has divided astronomers into two classes, those who talk about things to be done, and those who go to work and do them. In the present case I am afraid we shall have to enroll ourselves in the first class, because it is not easy to do anything in this matter, the situation in this country not being favorable to the determination which we have in view. You are doubtless all aware of the great interest attaching to this remarkable asteroid. It may be said to supply us with what we have long been wanting, an object admitting of exact observation, which at proper intervals will come so near the earth that the solar parallax can be determined with greater precision than by any other method. It would hardly be possible to get one more exactly to fill the bill. The minimum distance of Eros from the earth is 0.15 of the distance of the earth from the sun. It follows, therefore, that at certain times it will be about as near to us as observations can advantageously be made. Were it to come very much nearer the additional advantage would be slight, for the reason that the elements of its orbit could hardly be known with sufficient accuracy to give us greater advantage; 0.15 is all that we can ask for, since that distance will diminish the effect of errors of observation by six or seven times. We have made very little progress in this direction for fifty years, and may now hope for something more. Yet in Eros, the Fates or whoever rules our destiny, have supplied us with something very tantalizing. It turns out that the nearest approach of Eros to the earth occurs only on rare occasions. A nearest approach occurred in 1894, and another approach as near as that will not occur until after the middle of the coming century. But an approach as near as can occur in the next twenty years will take place in the coming autumn, when its minimum distance from the earth will be about 0.3, or twice its absolutely shortest distance. It is very desirable that astronomers who devote their attention to the determination of the solar parallax, should take advantage of this opportunity for we shall have a parallactic displacement of Eros exceeding three times and possibly five times the solar parallax. But there are many drawbacks, the planet is faint; it will probably be, when nearest to us, but little above the ninth magnitude, and it will therefore be scarcely possible from its rapid motion to photograph it, or to ascerits true position upon the plate at any given time. It is difficult to ascertain just how the observations upon it should be made. With the view of getting the ideas of those who are interested in the matter, and of ascertaining how the stations can best be planned, I have published in the *Astronomical Journal* a paper upon this subject, accompanied by diagrams, to aid in the selection of the observing stations. These diagrams give four projections showing the position of the earth as seen from the direction of Eros, at different periods during the opposition. (A copy of one of the diagrams was placed upon the blackboard.) If we imagine an observer looking down upon the earth from Eros, the relative parallax between any two points upon the earth's surface, will be the distance of those two points as seen by the observer upon the planet. These diagrams therefore show us the advantages and disadvantages of any two stations we may choose. The line of sunset, showing when Eros will be visible to us, will be nearly the same for several nights in succession. Taking for example December 16th; in that part of the earth upon the left of the diagram, it will be day, and observers there cannot see the planet at all. It is only in the remaining region that an observer can see the planet. I will mark upon this portion degrees of latitude, showing the position of different observatories. On the circle of 60° north latitude, Pulkowa and Helsingfors are situated, their position upon the circle depending upon the time of observation. It is evident from the diagram that the parallax at those points will be very great; and those two places have the advantage of being near one end of the base line giving the greatest observable amount of parallax. The asteroid being so far north on December 16th, does not set at all at those places. It is evident that the best corresponding point, giving the longest base line, will be in the portion of the diagram south of the equator. The planet at that time is only visible about 15° south of the equator and the only observatory in that region is at Arequipa. If then observations are made at the Arequipa observatory, for an hour or two, and if observations are also made at Pulkowa or Helsingfors for an hour or two, it will give us the longest possible base line for these observations. Observations may be made at other points, but they will be less available in the determination of the parallax than those made at Pulkowa or Helsingfors and at Arequipa. Another point for consideration is that if the two sets of observations are made at different times, the planet will be moving in the meanwhile. Its motion is very rapid, aud an element of uncertainty is introduced by the necessity of determining the amount of this motion. If the observations at Pulkowa or at Helsingfors and at Arequipa are not simultaneous this uncertainty affects the result. The question arises therefore whether simultaneous observations can be obtained at the ends of this base line. To determine that question we have only to imagine a map of the world upon this diagram. As the observer at Eros comes in sight of the oceans and continents of the earth, passing before him, he will see the two stations, at Helsingfors and at Arequipa; and observations cannot be simultaneous unless he can see both at once. We see that the conditions are extremely favorable. While Arequipa is passing along in *this* region, near the sunset line, Pulkowa will be passing along in *this* region, near the opposite horizon; so that we may combine observations made at Arequipa early in the evening, near the end of twilight, with those at Pulkowa several hours later in local time, in the latter part of the night, and they will be nearly if not quite simultaneous. We can thus obtain the maximum parallax, which will be 48″, with a little allowance for motion, from the observations of those two stations. Later in the season the Cape of Good Hope will appear above the horizon, and then another combination can be made, the circumstances will be less favorable. We might have observations at Paris, Greenwich, Potsdam, etc., but they will afford less favorable means of comparison than Pulkowa and Arequipa, which give the longest possible base line. As to our own position, we can observe in connection with Arequipa, but not easily; and in connection with the Cape of Good Hope, but when Eros rises with us it will set at the Cape of Good Hope. On the whole we cannot too strongly impress upon Professor Pickering the desirability of getting at Arequipa the best observations that can be made there, for combination with all the other stations. As to the method of making the observations, undoubtedly we must depend upon photography. There is no heliometer at Arequipa, and at the Cape it is not certain that it is available. It will not do to depend upon the heliometer. We must depend upon photography, and it is not easy for one not an expert to make valuable suggestions with regard to that. An additional complication arises from the rapid motion of the planet. It does not appear certain that the planet can be photographed at all so as to be available for this purpose. It must rest in one position long enough to take a picture or there will be no trace of it upon the plate. Professor Pickering says that there will be no difficulty in getting a trail; but that will not answer the purpose. In view of the fact that most of the stars will be brighter than the asteroid, photographs may be taken by focusing upon the planet and taking a trail of the brighter stars. But the difficulty remains of getting the time from the trails. Another difficulty is that we have no first-class photographic apparatus in the equatorial region, available for this purpose. I conclude that the combination of Pulkowa and Helsingfors with Arequipa ought to be our main reliance for obtaining the value of the solar parallax.

G. A. Peters. I should think that owing to the fact that the planet is upon the horizon during the observations for parallax, the light would be much diminished, and that the photographic plan would in that respect suffer a disadvantage in comparison with observations obtained visually. Unless large telescopes are used, and the atmosphere is extremely clear, there is danger that no observations can be obtained in that way.

Professor Newcomb. It is fortunate that at the stations where the planet is near the horizon the heavens are remarkably clear. At Arequipa, Pulkowa and Helsingfors the vapors near the horizon are but a minute fraction of those in the clime of Washington. It is a curious meteorological fact that here the vapor is generally so dense that good seeing near the horizon is much more rare than at the stations selected.

C. C. Abbott. Would it not be well to use isochromatic plates?

Professor Newcomb. That is a detail that we shall probably have to leave to those who take the photographs.

S. J. Brown. I have given this matter

some attention. It seems to me that micrometric observations could be carried on simultaneously, especially in the United States. We have Pulkowa, Strassburg, Charlottesville, Evanston, Madison, Princeton, Washington, and the Lick Observatory, and the Yerkes, where work can be advantageously done with large telescopes. While the factor of the parallax is very much smaller in the case of simultaneous micrometric observations, the main thing seems to be to secure the necessary co-operation, and to prepare a careful plan beforehand. The motion of Eros is so large that the observations will have to be very nearly simultaneous. The difference in the factor for parallax between Pulkowa and Washington is about 1.1. It is not much greater between Pulkowa and the Lick Observatory. It is 1.92 at Charlottesville; 1.26 for the Lick Observatory, 1.13 for Washington, and about the same for Princeton; so that by simultaneous observations between Pulkowa, Strassburg, Greenwich, and the observatories in the United States, we may obtain a parallax of about 15″ between the 1st of October, and January 16th. My impression is that stars should be selected not more than 60″ from the planet, and that they should be compared at nearly the same Greenwich mean time at all the stations. In this way observations may be obtained extremely valuable for determining the parallax. I am not certain but that the planet can be photographed to advantage: but it would require a long time, and the motion of the planet would be uncertain; so that the advantage I think would be outweighed by the accuracy with which micrometric observations could be made; and if referred to the same stars, eliminating the motion of the planet, we might expect precision. The position of the planet can be ascertained closely enough, and its parallax known so nearly that we can measure it to advantage in telescopes varying from 16 to 40 inches in aperture in the United States. I had started to draw up a letter to be sent to the directors of the observatories of Pulkowa, Strassburg, and Greenwich in Europe, and in this country at Charlottesville, Princeton, Madison, the Yerkes and the Lick, asking that co-operative work might be carried on, and asking for a selection of the stars. If we assume 60″ for the greatest distance from the planet, and a parallax varying from 15″ to 30″, this will give a distance from 60″ to 90″; and you can go down to the 10th magnitude, the magnitude of the planet, and find in the field a number of suitable stars, which should be symmetrically situated in rectangular co-ordinates. In this way it seems to me that we can obtain from these large telescopes observations of as great accuracy as those obtained by the photograph, although the distance may be twice as great and the factor twice as great. I do not see that anything practical can be done by this association. It must remain for some one to take the initiative; and there ought to be no difficulty in getting suggestions to perfect such a simple plan, such as may result in saving the day for the observations of Eros. Photographic observations would have to be confined largely to Pulkowa, Berlin, or Potsdam, and Arequipa, the Cape of Good Hope will not come in until along towards the end of the opposition. It seems to me therefore that micrometric observation, under these circumstances will be a matter of considerable importance.

Professor Newcomb. We want the stars as nearly of the same magnitude as possible. In a space 60′ square, the mean distance of the stars would be about 6′. The planet moves about 2″ of arc in a minute. An observer making a careful micrometric measure must take at least ten or twenty seconds to make up his mind about the bisection. During 10 seconds the planet will have moved over a space of $\frac{1}{3}$″ of arc, a quantity not appreciable but still large enough to leave open the question whereabouts during that period of 10 or 20 seconds occupied in making the bisection, the planet actually was at the time assumed for the bisection. There arises an uncertainty which may be systematic. It may be different for different observers and for different places. This uncertainty seems to preclude dependence upon the process of micrometric measurement. In the case of the satellites of Saturn we know that results are obtained differing enormously.

S. J. Brown. And for the satellite of Neptune the difference is still greater.

Professor Newcomb. There are some systematic differences attending micrometric observations, but these can be diminished if we take our observations to avoid them. We have the method of difference of right ascension and declination, when we take the right ascension entirely free from the declination, taking the right ascension at the time of passing a certain thread. If the star is chosen of about the same magnitude as the planet, it will be free from one source of systematic error, but there may be a great many others. If each set requires a minute or two, and if two threads are used, you may make 60 comparisons in an hour, which I think will be more than can be done with the micrometer. There is then much room for systematic error.

G. W. Hough. I think the most accurate work can be done with the micrometer. With an 18½-inch telescope there is no trouble in seeing an 11th or 12th magnitude star; and it is only necessary to get the time of the bisection and the position angle and distance. The time can be known within a few seconds, and ten observations can be made as readily as one. So we can get a final result free from systematic error.

Simon Newcomb. That may be quite possible for a 12th magnitude star.

G. W. Hough. The method of differences of right ascension and declination I use very often; but then we must depend upon the stability of the telescope. It may require 1½ to 2 minutes to pass from the star to the planet, and there is a liability to error from the action of the wind or from other causes. In photographic work the star will be near the horizon at the time required for its observation, and the time required will be very long, especially if we use isometric or other such plates; and that will be a great objection.

W. W. Campbell. It seems to me that both the methods suggested should be submitted to actual trial before the entire campaign is based upon either method. It ought to be possible by means of known asteroids moving rapidly to obtain photographs, by allowing the stars to trail or the asteroid to trail, and we could learn with what accuracy the position of the asteroid can be obtained upon a certain plate. Furthermore it will be easy to test the method of observing faint stars near the asteroid. In large telescopes it will be possible either to get a star of the 12th or 13th magnitude within 1′ of arc, and by selecting stars in different directions from the asteroid it will be possible to eliminate practically all the personal element entering into the question. In my experience in micrometric measures there is never an uncertainty greater than 2 or 3 seconds as to the exact instant of bisection, and the motion of the planet in that time, for that particular observation, will be small as compared with the accidental error probably made. If we take ten observations together the motion of the planet will be practically unimportant. My main point is that the method fixed upon should be actually submitted to test before the campaign is started. It would be a serious matter if the campaign should be carried on, and afterwards it should be ascertained that in consequence of some oversight the results are of very little importance.

G. C. Comstock. If 12th magnitude stars are to be used in the comparisons, can provision be made to secure the observation of the same stars at the different stations?

W. W. Campbell. A photographic plate can be secured from which the accurate positions of these stars can be ascertained.

G. C. Comstock. Is there time for this before the campaign begins?

W. W. Campbell. I think there should be a carefully prepared plan.

S. J. Brown. In relation to the observation of differences of right ascension and declination, all the observations will have to be made before we can determine the corrections, because the changes of right ascension and declination will not be in proportion to the elapsed time in consequence of the rapid motion of the asteroid. We need to eliminate the systematic errors. You mark your time, and your measurement does not correspond with the time you have marked. That leads to a systematic error. If we can eliminate this I think that observations of great accuracy can be made. In this case it is proposed to select stars which shall not be more than 30 seconds in time away from the planet. In micrometric measures the suggestion is 60″, which added to the displacement of the planet amounts to 90″. Above that distance there would be a rapid increase of probable errors. The main difficulty appears to be in the selection of stars down to the 11th or 12th magnitude.

W. W. Campbell. It seems to me that the method of observation of transits is objectionable. With the equatorial telescope there is a tremendous personal equation in the observation of stars and comets. Undoubtedly there will be a similar personal equation in the observation by transits of an asteroid and a faint comparison star differing 3 or 4 magnitudes from the asteroid. There are many things that may occur; the refraction may be changed, or the position of the instrument may be changed if we wait a minute or two for the comparison star to come along. Our experience in the observation of comets shows that very much better observations can be secured if we throw overboard the method of observing differences of right ascension and declination.

G. W. Hough. I disagree as to the time required for the observations, and I have made thousands of observations of differences of right ascension and declination. But one measure of the position angle is better than anything you can get from differences of right ascension and declination.

S. J. Brown. We have to shift the micrometer 90° in taking the position angle. Suppose the planet to move 1″ per minute, the change in the angle is not proportional to the time, and the change in the distance is not proportional to the time. I have come to the conclusion that differences of right ascension and declination can be determined with greater accuracy than differences of position angle and distance. One point we wish to agree upon is a uniform method of measurement. Observations cannot well be compared if one observation is made upon one plan and another observation upon a different plan. I have no doubt that the difference in magnitude is a very important factor in determining the position. In my observations of Titan I reduced my observations by the method of least squares, and all the equations gave positive residuals except one; and that could only be explained upon the theory of a variable personal equation from difference of magnitude. Even with faint stars it would be difficult to use differences of right ascension observed with the chronograph or eye and ear. I think we ought to have the experience of those who have had experience with stars of the magnitude to be used as to their method of treating them. The photographic method I think is subject to special dangers on account of the low altitude of the asteroid in the southern hemisphere.

W. W. Campbell. The base line which Professor Newcomb has indicated has a great extent, but as to successful working much depends upon a wise compromise which ought to be considered. At the expense of longer observation the observers are going to work near the horizon, where the refraction will be more uncertain. Furthermore the image to be measured will not in all cases be satisfactory on account of the vapors rising near the horizon. What amount of difference in the base line will outweigh the differences in the atmosphere we shall have to compete with? It appears to me that a base line which gives only two-thirds of the parallax may be more accurate than one which gives five-sixths, in consequence of the better conditions under which the observations may be made.

G. C. Comstock. We should not be misled by the drawing upon the blackboard, because it is not drawn to scale. Taking the indicated positions, we shall not bring our observations very near the horizon. I agree that we should not seek the maximum possible base line, there are other considerations in the problem, but we should get the longest base line we can without encroaching upon the horizon, and Pulkowa and Arequipa do not crowd the observations upon the horizon.

S. J. Brown. We have to take the telescopes as they can be found. At Pulkowa they have an excellent telescope, and at Arequipa also; and they are of identical power. These two stations are fixed, therefore, by the facts of the case. And so the Cape of Good Hope will be fixed as another station. The photographic program is fixed. I think the matter will be settled according to the circumstances as they exist now. We have three photographic telescopes of 13-inch aperture distributed very favorably in the southern hemisphere, and three or four in the northern hemisphere. The micrometric problem is one which I think the astronomers of America can agree to co-operate in, and I think we ought to have considerable influence in inducing Strassburg and Greenwich to co-operate with us. If we can secure the agreement of astronomers in this country and send word to those in Europe before October 1st, we may possibly save the situation, and perhaps produce results comparable in accuracy with those from the photographic plates. The planet may be observed at Pulkowa and Washington from October 1st to January 16th, the observations at Pulkowa extending to an hour angle of 6 or 7 hours. Then the planet would have an altitude of 30°; and the factor can be extended from 15″ to 30″ or even 35″. But I have been unwilling to write to foreigners until I could ascertain the opinions of astronomers here.

Winslow Upton. I think if Professor Pickering were here he would assure us that Arequipa is remarkably well situated to adapt it for a southern station. The condition of the climate and the atmosphere is favorable, and it has an elevation of 8000 feet above the level of the sea, ensuring good definition. Again, the twilight there is always short. We can be perfectly sure that Professor Pickering will use the facilities of the situation to the utmost. But there is a difficulty from the unknown law of refraction. The discussion of the observations will take the differential form, but the law is not known at all. These considerations do not apply to Pulkowa, but there the planet will not be low.

F. L. Chase. With regard to diurnal motion, will it be possible to eliminate the motion of the planet?

S. J. Brown. I think the micrometric method in that respect out of the question. The motion of the planet is about 10′ in 10 hours, and it would be difficult in a large telescope to measure that arc of 10′. We find that with the great telescope at Washington we are limited to 4′ or 5′. Beyond that we do not get good results. You cannot make the observations without shifting the eyepiece; and I have made up my mind that for the purposes of micrometric observation the diurnal plan would be out of the question.

J. G. Hagen. Referring to the photographic method, there is a difficulty which has not been discussed. The motion of the planet, in taking a photograph, which may require an hour or more, will produce a trail. There is an opportunity to choose between allowing the planet to trail, and allowing the stars to trail. Perhaps the same object, of securing an accurate position for the planet upon the plate, can be attained by interruption of the exposure. The time of the motion can be known within ten seconds; and while the planet, of the 9th magnitude, may be obtained upon the plate, the bright stars may be obtained in a series of dots, each exposure giving an independent determination. Whether these interruptions should be made once in ten seconds or once in a minute is a question for experiment. I merely make the suggestion of a method that may remove the difficulty.

Adjourned.

GEO. C. COMSTOCK,
Secretary.

WASHBURN OBSERVATORY.

SCIENTIFIC BOOKS.

Curing and Fermentation of Cigar Leaf Tobacco. By OSCAR LOEW. Report No. 59, U. S. Department of Agriculture. 1899. Pp. 34.

Physiological Studies of Connecticut Leaf Tobacco. By OSCAR LOEW. Report No. 65, U. S. Department of Agriculture. 1900. Pp. 57.

The great and growing importance of the tobacco industry in the United States has led the Department of Agriculture to undertake an extensive series of investigations, covering the mapping of areas of soil suitable for raising tobacco, studies in fermentation, improvements in breeding and selection, the conditions of growth and manipulation in foreign countries and the question of supplying tobacco to foreign markets. Dr. Loew has been detailed to carry out the chemical part of these researches, and the above-mentioned documents set forth the results thus far obtained by him and by others, and contain an abundance of material, both of scientific interest and practical importance.

From the consumer's standpoint essential constituents of tobacco are: (1) nicotine; (2) certain compounds, the chemical nature of which is wholly unknown, which impart to the leaf its acceptable flavor or aroma, and which differ in quality and quantity in different grades of tobacco. It is upon the latter, rather than upon the nicotine, that the commercial value of the prepared leaf mainly depends. The amount of nicotine is largest in the fresh leaf and undergoes marked diminution during fermentation, while the aromata are developed during the processes to which the tobacco is subjected. There is no apparent relation between the color, aroma and amount of nicotine.

The preparation of tobacco comprises two stages, curing and fermentation or 'sweating,' sometimes supplemented by aging or 'cold sweating.' During the earlier part of the curing stage the cells are still alive, and the resulting changes are physiological, embracing among others the transformation of starch into sugar, and the partial respiratory consumption of the latter, or its transference to another part of the leaf and reconversion into starch. After the death of the cells, the proteolytic and oxidizing enzymes attack much of the protein, fat and tannin, and give rise to changes of color and flavor. The curing stage is followed by one of fermentation, which goes on under the influence of air and moisture, and which is accompanied by a marked rise of temperature. During this stage there is a notable decrease of nicotine, but an improvement of flavor and aroma. The fermentation was ascribed by Suchsland to the action of bacteria, and he attempted to impart to German tobacco the peculiar Havana flavor by inoculation with pure cultures of bacteria obtained from the Cuban leaf, but without success. Perhaps the most interesting part of Dr. Loew's work is the proof that microbes play no essential part in the normal tobacco fermentation, and that the active agents are oxidizing enzymes. These exist in the green leaf, but are able to manifest their peculiar power of utilizing atmospheric oxygen also during curing and fermentation, when unopposed by the normal physiological processes of the living cells. At least three of these are present—an oxidase, a peroxidase and catalase. The documents contain much interesting information on the subject of oxidizing enzymes, together with speculative discussion of their nature and mode of action, which may or may not stand the test of future developments. With the revival of the study of catalytic phenomena now in progress from the standpoint of physical chemistry it is to be hoped that vegetable physiology will not have to wait long for important light on this still obscure subject.

The documents encourage the hope that the preparation of tobacco, which up to the present has been based on empirical procedure, will before long be conducted in as scientific a manner as is already the case with alcoholic beverages. They also afford an excellent illustration of the manner in which a government department, existing and working solely for practical purposes, is nevertheless compelled to encourage studies of broad scientific interest.

H. N. Stokes.

The Birds of Eastern North America. Part II, Land Birds. Key to the Families and Species. By Charles B. Cory. Illustrated. Special edition printed for the Field Columbian Museum, Chicago. Boston. 1899. Small 4to. Pp. 131–387.

Ornithologists, during the rapid growth of popular bird study in the past few years, have witnessed the production of all kinds of bird literature. In the great variety that has been put forth, the general effort has been for untechnical descriptions with sufficient accuracy to stand the test of practical utility. Mr. Cory has accomplished this end to a considerable degree in several of his books. In the 'Land Birds,' we have neither an exhaustive manual nor a pocket key, but an easy ornithology for beginners in the shape of a profusely illustrated key. It is continuous in pagination with the volume already published on the water birds and the two are obviously intended to be used together, for the useful introductory preface and glossary of the first part are not reprinted in the second. The book begins with a key to families, illustrated by outlined drawings of bills, wings, tails, and feet, and much reduced halftones of species characteristic of the various families. After this comes the key to species, which is the body of the book; then follows a systematic list of both land and water birds, giving in general terms the geographic distribution of each. The species are divided into groups by absolute characters, such as length of wing and distinctive colors, which could not be misconstrued even by the veriest amateur; technical terms are avoided as far as possible. The descriptions are brief, scarcely more than diagnoses, but more detailed than those of an ordinary key. The illustrations are not of uniform excellence, but serve their purpose fairly well. They are conveniently inserted in the text which refers to them and are repeated when necessary. The book is a little large for use in the field, but for the actual work of identification at the study table it should be a most valuable aid, particularly to the beginner.

W. H. Osgood.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of the Boston Society of Medical Sciences for June brings the fourth volume to a close and is accompanied by the index. The opening article on 'Pathological Changes affecting the Islands of Langerhans of the Pancreas' is by Eugene L. Opie, and 'The Influence of Defibrination on the Secretion of the Kidney' is discussed by Franz Pfaff and Vejux-Tyrode. 'A New Method of distinguishing Human from other Mammalian Blood in Medico-Legal Cases' is described by Ernest L. Walker, based upon the different characters of the granules of the polymorphonuclear leucocytes of the blood of various mammals and the ability to recognize these differences in dried blood by appropriate treatment and methods of staining. 'Some

Laboratory Apparatus' is noticed by Frederic P. Gorham and 'Methods of staining Flagella,' by W. H. Robey, Jr. Finally an abstract is given of a paper on the 'Action of Drinking-water on Metals,' by Charles Harrington, in which among other interesting points it is noted that the same water may act very differently at different times.

The Osprey for June begins with Part VI. of 'Birds of the Road,' by Paul Bartsch; some 'Bird Notes,' by Lady Broome, are reprinted from the *Cornhill Magazine*, and in the fourth part of William Swainson and his Times,' by Theodore Gill, we are told of his literary work. The editor discusses the 'Significance and Etymology of the Word Mammals,' calling attention to the fact that the commonly accepted derivation of the word is incorrect, and that the term Mammalia, from which it comes, was coined by Linnæus in analogy with *animalia*, to describe the class mammalia which he was the first to correctly define.

The Auk for July is an unusually large number, containing articles of much interest, not only to the professional ornithologist, but to the general reader. The 'Occurrence of *Larus glaucescens* and other American Birds in Hawaii' is noted by H. W. Henshaw, and this is followed by a graphic and gracefully written article, 'Notes on the Breeding Habits of the American Golden-eye Duck or Whistler,' by William Brewster. The 'Ecology of the Maryland Yellow-throat and its Relatives' is treated at length by William Palmer. 'Notes on a Few Species of Idaho and Washington Birds' are contributed by John O. Snyder, and a 'Description of a New Shearwater from the Hawaiian Islands' is given by H. W. Henshaw. A. W. Anthony tells of the Nesting Habits of the Pacific Coast Species of the Genus *Puffinus*.' E. W. Nelson gives 'Descriptions of Thirty New North American Birds,' and Reginald Heber Howe describes 'A New Subspecies of the Genus *Hylocichla*.' 'An account of the Nesting Habits of Franklin's Rosy Gull (*Larus franklinii*), as observed at Heron Lake in Southern Minnesota,' is given by Thomas S. Roberts, and the concluding paper 'Notes on a Collection of Bahama Birds,' is by Outram Bangs. The articles on nesting habits are all illustrated, the plate showing the burrows of the Wedge-tailed Petrels being remarkably interesting. The customary numerous notes and reviews complete the number.

THE *New York Medical Journal*, long published by Messrs. D. Appleton & Co., has been sold to Mr. R. Elliott, an advertising agent in New York City. It is to be hoped that the Journal will remain under the same editorial management as at present, as it is one of the few American medical journals that have consistently maintained a high standard.

The Proceedings of the Zoological Society of London for June contains Dr. A. Smith Woodward's full paper on the much-discussed remains of *Grypotherium* (*Neomylodon*) *listai* from Patagonia. The specimens are described in detail and the affinities of the animal made clear. They were found on the floor of a cave, in a large enclosure, associated with cut hay and much excrement, and Dr. Woodward concludes that we can hardly refuse to believe that this great ground sloth was actually kept and fed by an early race of man.

DISCUSSION AND CORRESPONDENCE.

KITE *vs.* BALLOON.

EDITOR OF SCIENCE: The high kite-flight decribed in SCIENCE of July 6, 1900, was exceeded on July 19th, when, by means of six kites attached at intervals to four and three-quarters miles of steel wire, the meteorograph was lifted 15,170 feet above Blue Hill, or 15,800 feet above the neighboring ocean. At the time that the temperature was 78° near the ground, it was about 30° at the highest point reached, the air being very dry and the wind blowing from the northwest with a velocity of 26 miles an hour.

The altitude reached in this flight probably exceeds the greatest height at which meteorological observations have been made with a balloon in America. The highest observations that have been published were made by the late Professor Hazen of the Weather Bureau in an ascent from St. Louis, June 17, 1887, to a height of 15,400 feet.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY.

CALLOSITIES ON HORSES' LEGS.

To the Editor of Science: Your inquirer concerning the callosities on horses' legs might gain an indirect suggestion from Ernest Seton Thompson's 'Wild Animals I Have Known' or—still more probably—from the same author's recent articles in the *Century Magazine* on the National Zoological Park. The suggestion that these callosities are vestigial organs for the secretion of specific perfumes gains some indirect but interesting support from the use made of their material by Rarey and other professional 'horse-tamers.'

W J McGee.

NOTES ON INORGANIC CHEMISTRY.

In a study of the radiation of uranium, Becquerel finds that these rays are deviated in a magnetic field. When the uranium compounds are treated with barium salts and the barium then precipitated as a sulfate, the radio-activity of the uranium is decreased, but Becquerel has not been able in this way to obtain a uranium salt which does not show some activity.

A somewhat similar series of experiments is described by Béla von Lengyel in the *Berichte.* The barium sulfate obtained from the uranium mixture was found to be strongly radio-active, as well as the barium carbonate and chlorid derived from this sulfate. The author considers this synthesis of radio-active barium renders the existence of radium and polonium as elements exceedingly doubtful. This reminds one of the views of Le Bon that radium and polonium are merely allotropic states of barium and bismuth, corresponding somewhat to the inactive and the phosphorescent calcium sulfids.

Accounts have been published from time to time in the *Comptes Rendus* by Paul Sabatier and J. B. Senderens on the addition of hydrogeu to acetylene under the influence of reduced metals in a finely divided condition. The action of copper, iron and cobalt have been most recently described, the union taking place below 200°. With copper, ethane, ethylene, and other hydrocarbons are formed, and if hydrogen is in excess no acetylene is unacted upon. With iron in addition to ethane and ethylene, benzene and higher unsaturated hydrocarbons are produced. Cobalt is found to give a much larger yield of ethane than nickel.

The direct preparation of a number of binary compounds of aluminum is described by Henri Fonzes-Diacon in the *Comptes Rendus.* The sulfid, selenid, phosphid, arsenid, and stibid are all formed by the ignition of a mixture of fine aluminum powder with the element in question. In the case of sulfur and selenium, a little burning magnesium is necessary to ignite the mixture; with antimony, sodium peroxid serves the same purpose. When these compounds are treated with water, the hydrogen compound is evolved in a very pure state. In the case of phosphid the yield of the non-inflammable gas PH_3 is practically theoretical, and the same is true of arsin. The yield of stibin is less good.

A recent *Bulletin* of the College of Agriculture of Tokyo, contains a paper by Dr. U. Suzuki on the possible replacement of calcium in plants by strontium and barium. From an abstract in *Nature* it appears that both strontium and barium salts are poisonous to plants, though the addition of lime salts lessens the poisonous action to some extent. This is apparently very different from the action on higher animals, where, though barium is strongly toxic, strontium has little if any toxic action.

From *Nature* we note also a short article by C. E. Stromeyer from the *Memoirs* of the Manchester Literary and Philosophical Society, on the Formation of Minerals in Granite. He concludes that the temperature of granite formation need not be limited, nor need the interior of the earth be assumed as solid. The mineral composition of granites depends not only upon temperature and rate of cooling but also upon pressure. "Where the solid rock resting on the molten material is of low specific gravity and a bad conductor of heat the depth at which granite rock would commence to solidify would not be great, and most probably the quartz would crystallize first, forming, say, quartz-porphyry." In somewhat opposite conditions, at greater depths and pressure the quartz would remain fluid longer, forming feldspar-porphyry. Every intermediate condition is also conceivable.

THE curious observation is made by P. Villard in the last *Comptes Rendus*, that at the temperature of 1000° fused silica, SiO_2, is permeable to hydrogen.

THE abstract of a paper read before the Chemical Society (London) by John Wade on the constitution of hydrogen cyanid, is given in the last number of the *Proceedings*. From reactions with alkyl iodids and sulfates, it has appeared as if potassium cyanid had the constitution KCN while that of silver cyanid is AgNC. Wade now shows that when potassium cyanid is heated with alkyl potassium sulfate at a lower temperature, the isomeric isocyanid is often the principal product. He further finds that practically all the isocyanids can be converted into cyanids (nitrils) by heat. Since the formation of nitrils in the above interaction is thus accounted for, one of the chief arguments for the nitrilic constitution, HCN, of hydrogen cyanid disappears, and it seems possible that HNC represents the constitution of the acid, and that all the cyanids have an analogous constitution.

J. L. H.

MEDICAL EXHIBITS AT PARIS.

THE Paris correspondent of the *British Medical Journal* gives the following account of some of the medical exhibits at the Paris Exposition :

In the Pavillon des Armées de Terre et de Mer, at the end nearest the Pont de l'Alma, we first enter the Salon Pasteur. On either side of the entrance are cabinets filled with cultures of different microbes. In the center of the room is the bust of Pasteur on a pedestal, round the base of which is an octagonal case containing a retrospective exhibition of the work of Pasteur. Here we see the manuscript of the thesis presented before the Faculty of Science in 1847 on molecular dissymmetry; the microscope used by Pasteur to measure the angles of crystals, and models of various crystals ; his work on fermentation, with the original apparatus used for the study of butyric acid fermentation, and the apparatus for the study of living anaërobic microbes. Pasteur's researches on spontaneous generation are illustrated by the apparatus to prove that calcined air contained no germs, and the flasks used in the experiments on the organized dusts in the atmosphere, and opened by him on October 3, 1860, at the summit of Mount Poupet. In connection with his investigation into the diseases of wines and beer, flasks for the pure culture of yeast and experiments on the aging of wines are shown. The microscope used by Pasteur in his investigation of the diseases of silkworms is shown, together with baskets for rearing silkworms, chains of cocoons, and pigeon-holes for rearing isolated worms. Methods of sterilization are illustrated by the first model of the Chamberland autoclave used in Pasteur's laboratory, and by Chamberland filters. Virulent diseases are illustrated by the flask of putrified blood from which Pasteur obtained the anaërobic microbe which he called the 'vibrion septique.' U-shaped tubes from Pasteur's laboratory containing anthrax blood, with samples of the first and second vaccines against anthrax as supplied to veterinary surgeons are exhibited. Down to January 1, 1900, in France alone, 4,971,494 sheep and 708,980 cattle have been inoculated. Some manuscript notes by Pasteur on the experiments in his laboratory in 1881 on hydrophobia are shown, as are also his platinum spatula instruments for trephining rabbits and to remove the spinal cord, dried cords, etc.

On the right-hand of the Salon Pasteur is a model of the Pasteur Institute, with the recently completed Annexe of Biological Chemistry and hospital for hydrophobia and diphtheria patients. An adjacent glass case contains a bouillon culture of the bacillus of diphtheria in a large flat-bottomed flask, the trocar of Roux and Nocard with rubber tube to collect the blood from the immune horse, the jar in which the clot and serum separate ; a small filter by L. Martin for experiments on the toxin, the large filter used to filter the cultures of diphtheria to prepare the toxin, the filtered culture, and bottles of the serum in liquid and dried form.

On the left-hand side is the exhibit of the Pasteur Institute at Lille, showing cultures of the plague bacillus of Yersin-Kitasato and the antiplague serum ; venomous snakes, with Calmette's serum against snake bite ; the sterilization of water by ozone, with numerous maps, plans and photographs of the Lille Institute.

In small rooms leading out of the Salon Pasteur is a portion of the hygiene exhibit of foreign nations, the major portion being in the Champ de Mars. Germany here shows a large model of the Imperial buildings for sanitary administration, a map of the mineral waters of Germany, numerous plans and elevations of the many sanatoria for the open-air treatment of consumption; also numerous graphic models to show the increase in the population, the fall in death-rates, the hospital accommodation, etc., the most striking being black and red cubes showing the number of deaths from small-pox in 1862–76, that is, 199,410, compared with the number of deaths in 1882–96, that is, 3291; in 1897 there were only five deaths from small-pox. Vaccination and re-vaccination became compulsory by law in 1775.

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*SIGMA XI, THE AMERICAN ASSOCIATION AND THE GEOLOGICAL SOCIETY OF AMERICA.**

An unsigned article in SCIENCE (June 22d) entitled 'Sigma Xi at the American Association for the Advancement of Science,' calls attention approvingly to a movement to associate meetings of this Greek-letter society with those of Association. The rapid rise of the Sigma Xi in American universities is cited, and it is affirmed that "as an honor society it promises to take a leading part in our universities in which science holds a prominent place." It is urged that "it has become a representative honor society for the ablest students of science in the institutions where it is established." Respecting its intent, the following authoritative quotation is made: "In establishing a new chapter * * * in each case we should make sure that we entrust the power of distributing the honor of membership only to such persons and institutions as are capable of giving the education and training necessary to the carrying on of scientific investigation."

It is scarcely necessary to make these quotations to show that the fundamental feature of the Society is the promotion of a class distinction based on academic preparation. However laudable this may be in itself considered, it would seem to be inharmonious with the fundamental purpose of the Association, which is the development and dissemination of science among all people without regard to race, age, sex or previous conditions of intellectual servitude.

From professional relations the writer should not be inappreciative of the value of university training and of academic achievement. Nevertheless, it seems to him that the purposes of the Association are unqualifiedly democratic and that the spirit of science is equally so, and that therefore the only distinctions which the Association should foster or sanction, if it fosters or sanctions distinctions at all, are those which are based solely upon scientific productiveness. And this productiveness should be honored quite irrespective of its connection with the fortunate conditions of academic appointments and opportunities, or with the adverse or even hostile conditions under which much good science has been developed. The movement therefore to connect the Sigma Xi with those of the American Association seems incongruous.

As set forth in another article in the same number of SCIENCE, some fifteen special scientific societies have already become correlated with the Association and have much increased the complexity of the proceedings. This movement seems to be an inevitable consequence of the differentiation of scientific work, and is scarcely less than necessary to the continued success of the Association, but it has already brought some inevitable conflict of interests and not a little congestion of programs and appointments. Between these and the increased number of social functions, it has already come to pass that there is little time left for that personal conference and that informal sociability whose basis is 'shop talk,' which formed so large a factor in the attractiveness of the earlier meetings of the Association. If now in addition to these laudable complications, the attention of a considerable number of the members of the Association is to be diverted in the interest of an academic honor society and a precedent established for the meeting of other societies whose basis is not strictly congenial to that of the Association,

*Editorial article from the *American Journal of Geology.*

it is not clear where the limit of congestion will be found.

Between the lines of the article referred to, the imagination is tempted to read a hint of a desire for that rank and dominance in the Association which the members of Sigma Xi attained in university circles, and it is not unnatural to anticipate that the fraternity might unconsciously play a part in Association politics not unlike that for which Greek-letter societies are famous throughout the university world. To those who pride themselves upon rank and band themselves together because of rank it is not unnatural that official expressions of rank should be sought through the unconscious influence of fraternization.

It is not altogether foreign to the subject of this discussion to note the increasing encroachments of formal social functions upon the meetings of the Association and not less perhaps upon the meetings of the Geological Society of America. Without doubt a certain measure of formal contact with general society is helpful to the ends sought by the Association. At the same time it must be recognized that formal social functions are largely the province of the leisure class and that from the very nature of the case they remain so, for leisure and the means of leisure are prerequisite to their effective cultivation. Equally from the nature of the case, the devotees of science do not usually belong to the leisure class because real success in science involves strenuous endeavor and an almost unlimited devotion of time. The diversion of time to social functions during the meetings of the Association should, therefore, be zealously watched and restrained within limits which are compatible with the efficient conduct of the primary purposes of the Association. Particularly is this true of the Geological Society which has no organic relation to general society. The movement in the direction of social formality has already crowded hard upon the point where the first requisite preparation for a meeting of the Association or of the Geological Society is the packing of a dress suit, and the second is the preparation of an after-dinner speech, preparations that are none too congenial to the great mass of hard workers in science.

SCIENTIFIC NOTES AND NEWS.

A BUST in bronze of M. de Lacaze-Duthiers was presented to him on July 1st by representatives of the University of Barcelona, consisting of the rector M. de Luanco and Professors Lozana, Mundi, Arazona, Lopez-Sancho and de Odan Buen. M. Gréard, vice-rector of the university of Paris, M. Frederic of Liège, M. Delage of the university of Paris and M. Leygues minister of public instruction, made addresses to which M. de Lacaze-Duthiers replied.

DR. J. HOWARD GORE, professor of mathematics and geodesy at Columbiau University, Washington, has been appointed by President Loubet, juror-in-chief of the Court of Appeal of the Paris Exposition. He is already juror-in-chief of the International Congresses for the United States.

ON the occasion of the celebration of its centenary, the University of New Brunswick, at Frederickton, conferred an honorary degree on Dr. J. G. Adami, professor of pathology in McGill University.

DR. BENJAMIN IDE WHEELER, of the University of California, has returned from his visit to the East, during which he was given the LL.D. degree by Harvard and Brown universities.

MR. JOHN C. MERRIAM is at present in the fossil fields of eastern Oregon, where he has charge of an expedition making paleontological collections for the University of California.

DR. HERMANN TRIEPEL has been appointed prosector at the Anatomical Institute at Greifswald.

THE death is announced of Mr. Georges Marye, curator of the museum at Algiers.

THE Rev. Thomas D. Weems, of Decatur, Ill., has given his archæological collection, numbering eleven hundred and forty specimens, to the Powell Museum of the Illinois Wesleyan University. The collection contains figures, vases, pictured stones, ceremonial stones, tablets, pipes, arrowpoints, spearpoints, celts, sinkers, knives, saws, hammers, scrapers, plummets, discoidals, mortars, pestles and copper, bone and shell implements and ornaments.

The Rev. Dr. John A. Kumler, of Springfield, Ill., has offered to provide for the cases to contain the above collection.

A Society for School Hygiene has been established in Germany and will hold its first meeting at Aix la Chapelle, in connection with the meeting of German Men of Science and Physicians beginning on September 17th.

The position of physicist in the Geological Survey will be filled by a civil service examination on August 21st and 22d. The salary of the office is $1800 per annum. The subject of examinations and the weights are as follows:

1. English (essay)	8
2. German	8
3. French	8
4. Laboratory training	28
5. Mathematics	20
6. General physics	28
Total	100

A telegram was received on July 24th at the Harvard College Observatory from Professor W. R. Brooks at Geneva, N. Y., stating that a bright comet was discovered by him July 23d at 13^h (premsumably Eastern time), in R. A. $2^h 43^m 40^s$ and Dec. $+ 12° 30'$. Motion northerly. Stellar nucleus and tail. A subsequent letter from Professor Brooks states that he found the position of his new comet July 26, $13^h 25^m$ Eastern time ($18^h 25^m$ Greenwich Mean Time) to be in R. A. $2^h 46^m 30^s$ and Dec. $+ 21° 1'$.

The Conference Scientia, an informal society organized at Paris for social purposes, held its sixth meeting on June 28th, the occasion being a banquet in honor of M. Darboux, the eminent mathematician. An address was made by M. Ch. Richet to which M. Darboux replied.

More than 300 papers have already been offered for the meeting of German Men of Science and Physicians which takes place at Aix la Chapelle beginning on September 17th. General addresses will be made by Professor Van't Hoff, Berlin, on the 'Development of Chemistry'; by Professor Oscar Hertwig, Berlin, on the 'Development of Biology'; by Professor Naunyn, Strasburg, on 'Internal Medicine including Bacteriology and Hygiene,' and by Professor Chiari, Prague, on 'Pathological Anatomy and External Medicine.'

At a recent meeting of the Museums Association at Canterbury, Professor W. M. Flinders Petrie advocated his plan of building large but inexpensive sheds to house ethnological and archæological material. The plan is to acquire about a square mile of land within an hour's ride of London and to begin to build large galleries uniformly on what might be called a gridiron plan. The proposed galleries should be about 54 feet wide and 400 feet apart, so that after completion there would be room for additions six times as large on the intermediate ground. The plan would involve the construction of about 400 feet of gallery per year, or eight miles in the century, leaving six times the space to be covered by irregular additions as required. The financial demands of the scheme for land, building and staff might be met by a fixed charge of £10,000 per year.

The report of Commissioner of Patents Duell for the fiscal year ended June 30th last shows a total of 25,540 patents granted, including reissues and designs. The receipts of the office were $1,358,228, and a surplus of $110,402 was turned into the treasury.

For the past two months an installation of wireless telegraphy has been in operation at the lighthouse at Borkum and the light ship 20 miles away. Communication is established with the North German Lloyd Steamship *Kaiser Wilhelm der Grosse* in its voyage into and out of Bremenhaven and other shipping news is transmitted. This is the only wireless telegraphy installation transmitting ordinary intelligence on a commerical footing.

The Chancellor of the German Empire has issued an ordinance to the effect that the Réaumur thermometer will not be admitted to official control after January 1, 1901. This will lead to the exclusive use of the centigrade thermometer in Germany.

Lieutenant Peary's relief steamer *Windward*, has entered the harbor at Port au Basques, at the southwest extremity of the island, with part of her machinery disabled. Pieces to replace the broken sections have arrived, but it will probably require a few days to make the necessary repairs. The delay may seriously disarrange the ship's plans for reaching the far north.

THERE is again a new universal language to rival Volapük and Spokil, and which calls itself Bolak, in English the 'blue language' or 'the language colour of heavens.' We quote from the English circular issued from Paris. This language appears to be the joint production of Léon Bollack and Raoul de la Grasserie. The following extract is from the same circular:

"To give to all the possibility of receiving news from whole the world and of understanding them *without any translator.*

"To give to all the possibility of crossing whole the world and of making themselves understood *without any interpreter.*

"And a more generous IDEAL may be reached, owing to the coming of an INTERNATIONAL LANGUAGE which, letting remain the *native idiom* of each one, would become the unique FOREIGN LANGUAGE for ALL.

"It is indeed obvious to understand that this *facility of comprehension* between persons of different nationalities will forcibly raise a Holy Communion of thoughts and of pacification among peoples dealing together."

But we of the English tongue naturally ask why not adopt English as the universal language, since it is already more universal than any language has ever been in the history of the world?

THE daily papers report that Indians hunting on the east coast of Hudson Bay, north of Fort George, in the early spring, have a story that may eventually give the history of the fate of Andrée and his companions. Mr. George Renison, returning from Moose Factory, the Hudson Bay Company's post on the west coast of James Bay, says that the last packet from York Factory brought word that the Indians had found a quantity of wreckage, the bodies of two men and a man in the last stages of death. The Indians could not understand the language he spoke, but it was not English. He died while they were there, and they returned to their post without bringing away any evidence of the strange occurrence. As the Indians had never seen a balloon, the nature of the wreckage was judged only from descriptions given by them, but Mr. Renison says they described accurately a car and other fixtures that could belong to nothing else. Hudson Bay Company officers are firmly convinced that it is the Andrée party, and have sent out men, guided by the same Indians, to find and bring back evidence to establish the identity of the party.

A BRITISH Parliamentary paper has been published giving details of experiments performed on living animals in 1899. It appears from the abstract in the London *Times* that the total number of licenses in England and Scotland was 250, of whom 72 performed no experiments. Tables I. and II. give the names of all persons who held licenses during 1899. These tables afford evidence (1) that licenses and certificates have been granted and allowed only upon the recommendation of persons of high scientific standing; (2) that the licensees are persons who, by their training and education, are fitted to undertake experimental work and to profit by it; (3) that all experimental work has been conducted in suitable places. Table III. shows the number and the nature of the experiments performed by each licensee mentioned in Table I., specifying whether these experiments were done under the license alone or under any special certificate, so that the reader may judge which experiments (if any) were of a painful nature. Table III. is divided into two parts, A and B, for the purpose of separating experiments which are performed without anæsthetics from experiments in which anæsthetics are used. The only experiments performed without anæsthetics are inoculations, hypodermic injections, vaccinations, and similar proceedings, in which the pain inflicted is not greater than the prick of a needle. No experiments requiring anything of the nature of a surgical operation, or that would cause the infliction of an appreciable amount of pain, are allowed to be performed without an anæsthetic. The total number of experiments included in Table III. (A) is 1656. Of these there were performed under license alone 820, under certificate C 182, under certificate B 449, under certificate B + EE 205. In experiments performed under the license alone, or under certificate C, the animal suffers no pain, because it is kept under the influence of an anæsthetic from the beginning of the experiment until it is killed. In experiments performed under certificate B (or EE or F linked with B) the animal is anæsthetized during the operation but is allowed to recover. The number of inoculations for the diagnosis of rabies performed in 1899 was 164, the steady decrease during recent years noticed in the report for 1898 having been maintained. Table III. (B) is devoted entirely to inoculations, hypodermic injections, and some few other proceedings performed without anæsthetics. It includes 6813 experiments. The total number of experiments (8469) is somewhat less than in 1898 (9151). The licensees were found in all cases to be desirous of acting in strict accordance with the spirit as well as the letter both of the Act and of the special conditions attached to their licenses. In Ireland nine licenses were in existence during 1899. Of these four expired, one was renewed, and two new licenses were granted. The experiments performed were 227 in number, 79 being under license alone and 148 under certificates. Two licensees performed no experiments. The animals experimented on were 171 rabbits, 43 dogs, 12 guinea-pigs, and one rat. The experiments appear to have been of a useful character, and either painless or painful only to a slight extent. The bulk of them were inoculations for the diagnosis of diseases, such as canine rabies and tuberculosis.

The Moscow Society of Physiologists, a branch of the Imperial Society of Friends of Natural Science, has, according to the *British Medical Journal*, undertaken to issue a journal entitled *Le Physiologiste Russe*, which is intended to make the work of members of the Society in physiology, physiological chemistry, histology, embryology, general pathology, and pharmacology known to that large section of the scientific world to which Russian is an unknown tongue. Original papers will be published in French or German; and summaries of all Russian work appearing elsewhere will be given in French. The first volume, which has already been issued, contains papers from the laboratories of Moscow, St. Petersburg, Warsaw and Tomsk. Among the writers are Professor Morokowitz, head of the Physiological Institute of Moscow, and editor of the journal; Professors Setschenow, Bogdanoff, Salaskine, Chalfeieff, and Kulagin. *La Physiologiste Russe* is sent gratuitously to all institutes of physiology, pathology, and pharmacology. As giving some idea of the relative numbers of such institutes in different countries, it is interesting to note that Austria receives 31 copies, Great Britain, 23, Germany 46, France 42, other European countries 59, the United States 29, South America 4, Asia 5, Australia 3, Africa 1. *Le Physiologiste Russe* is published and distributed with the help of contributions from friends of biological science, who have subscribed a capital sum of £2000 for the purpose.

UNIVERSITY AND EDUCATIONAL NEWS.

Lord Calthrope and his son have given to the University of Birmingham about 25 acres of land for its scientific department. The site is very suitable, permitting the establishment of the department nearer to the center of the city than would otherwise have been possible.

Mr. Ewan Richards Frazer, of Balliol College, is announced as the donor of £5000 for a pathological laboratory at Oxford.

Trinity College has received from Mr. J. M. Allen, of Hartford, a complete set of the Proceedings of the American Asssociation for the Advancement of Science.

The trustees of Iowa State College in their annual session made the following additions to the faculty of the college: H. J. Burt of the University of Illinois, assistant professor of civil engineering, this being a new chair; B. S. Lampear of Cornell University, assistant professor in electrical engineering; Lewis E. Young of Pennsylvania State College, instructor in mining engineering; I. A. Williams of Iowa State College, 1898, instructor in mining engineering.

The vacancy at Toronto University caused by the retirement of Professor Pike from the chair of chemistry has been filled by the appointment of Mr. William R. Lang, who has for some years filled the position of lecturer in organic chemistry at Glasgow University.

Professor Brieger has been appointed to the newly established chair of hydrotherapy at Berlin University.

SCIENCE

FRIDAY, AUGUST 10, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*CERTAIN RECENT ATTEMPTS TO TEST THE NEBULAR HYPOTHESIS.**

IT is a far cry from the glacial period to the nebular hypothesis, but yet it is not beyond the view hulloa of logic. Glacial periods have certainly been dependent on atmospheric states, whatever else may have been concerned in causing them. Surely no one will imagine glaciation in the air of the putative molten earth, nor in the warm dense atmosphere currently assigned to the early ages, nor yet in the later periods when figs and magnolias grew in Greenland. If carbon dioxide has the thermal qualities which eminent physicists assign it, continental glaciation could scarcely have occurred while it was a large constituent of the atmosphere. Now the atmosphere has,

* This paper, prepared at the request of the editor of SCIENCE, is little more than an abstract of the following three papers:

I. 'A Group of Hypotheses bearing on Climatic Changes,' by T. C. Chamberlin; *Journal of Geology*, Vol. V., No. 7, 1897, pp. 653–683.

II. 'An Attempt to test the Nebular Hypothesis by the Relations of Masses and Momenta,' by T. C. Chamberlin; *Journal of Geology*, Vol. VIII., No. 1, January–February, 1900, pp. 58–73.

III. 'An Attempt to Test the Nebular Hypothesis by an Appeal to the Laws of Dynamics,' by F. R. Moulton; *Astrophysical Journal*, Vol. XI., No. 2, March, 1900, pp. 103–130.

By 'nebular hypothesis' the gaseous hypothesis of Laplace is always to be understood in this article. The arguments, for the greater part, apply also to all spheroidal hypotheses in convective equilibrium, whether gaseous or meteoroidal.

during its history, contained many thousands of times its present amount of carbon dioxide, as is implied by the vast stores of carbon and carbonates that have been removed from it. We are thus driven to assume either that the early atmosphere was very rich in carbon dioxide, and has been impoverished as the ages have gone on, or that the loss has been made good by supplies received concurrently. In the former case glaciation and similar phenomena dependent on an impoverished atmosphere should be confined to the later ages. But the most extraordinary glaciation of which we have any knowledge took place near the close of the Carboniferous period, or, in other words, far back in the geological series. Vast beds of limestone, coal, and other carbonaceous deposits have since been formed at the expense of the atmosphere's carbon dioxide. Much oxygen and some nitrogen have also been consumed, but we need not dwell on these. If all this carbon dioxide had been in the atmosphere at that time there is reason to doubt whether the glaciation of India, Australia and South Africa could have taken place. Besides, in the Permian and Triassic periods great salt and gypsum beds were laid down over many degrees of latitude and longitude on both continents. These imply an aridity of surprising extent, duration, and intensity, reaching to latitudes not at present affected by appreciable excess of evaporation over precipitation. If the atmosphere had been rich in carbon dioxide, which is believed to equalize temperature and humidity, there is reason to doubt whether these deposits could have been formed. But even still earlier, as far back as Silurian times, before the coal of the Carboniferous period or the carbon dioxide of the great limestones of the Subcarboniferous and the Devonian times had been taken out of the atmosphere, widespread and thick salt beds were formed in the St. Lawrence basin where now the excess of precipitation forms great lakes and a mighty river. Nor is even this the earliest evidence of notable aridity.

Now these and allied phenomena, which imply extraordinary inequalities of atmospheric states, call for a reconsideration of inherited views regarding the constitutional history of the atmosphere. To suppose simply that the atmosphere was once exceedingly rich in carbon dioxide and has been steadily impoverished does not seem to fit the phenomena. But when once a reconsideration is undertaken there is no stopping place short of the original state of the atmosphere, and we are at once involved in the *pros* and *cons* of the nebular hypothesis.

If the nebular hypothesis is approached from the atmospheric side, we must carry into the inquiry the modern kinetic theory of gases or give reasons for dissenting from its validity. In framing the nebular hypothesis a century ago Laplace could not call to his aid the present dynamic conception of gases, and, while this absolves him from responsibility, it makes it the more fitting that the hypothesis should be tested by the kinetic views that have grown out of researches since his day. These views may perhaps require modification in the future, but such modification is more likely to involve intensified molecular activity than the opposite.

Led thus to the subject, we have attempted to make a test of the nebular hypothesis by a comparison of the molecular velocities of the essential gases with the gravitative power of the earth, and its antecedent nebulous ring, to control these at the temperatures assigned them by the hypothesis. We have followed the general method employed by Dr. Johnstone Stoney in discussing the atmospheres of planets and satellites.* The essence of the method is

* 'On the Cause of the Absence of Hydrogen from the Earth's Atmosphere and of Air and Water from

this: The molecules of gases beat upon each other and rebound with great frequency and high velocities. Both the frequency and the velocities rise with temperature. The molecular velocity of a gas is *inversely proportional* to the square root of its molecular weight and hence for the lighter gases it is very high. The velocity of a particular molecule at any instant depends on the nature of the last previous collision, being sometimes much higher than the average velocity and sometimes much lower. Now it is obvious that if a molecule on the outer border of the atmosphere collides with another and rebounds outwards with a velocity so great that the attraction of the earth cannot overcome it, the molecule will fly away into space and be lost. Dr. Stoney has attempted to show that on account of the high velocities thus frequently attained, hydrogen and even helium are not permanently retained by the earth under present conditions. He has also endeavored to prove that the moon and other small bodies cannot retain any of the atmospheric gases, and that this is the reason they are without atmospheres, and this latter view is now quite generally accepted.

Mr. S. R. Cook, however, has attempted to show by mathematical analysis that the rate of loss of hydrogen from the earth is at present too small to be effective,* but he has based his computations on the theoretical parabolic velocity of the earth and not on its available power of control in competition with the sun and other bodies of the solar system, and he also neglected the ionization of the gases and the peculiar conditions of the upper atmosphere.* We have endeavored to show that whatever doubt there may be about the precise competency of molecular velocities to cause loss of the lighter gases at present, their retention would be put in jeopardy if the temperature of the earth were raised to 3500° or 4000° C. as would be necessary to restore the earth to the original gaseous condition postulated by the Laplacian hypothesis. At such temperatures water would be dissociated into hydrogen and oxygen, if not ionized to a higher degree; the molecular velocities of these gases would be exalted by the intense heat† and, in such a state of gaseous extension, the outer part would be far from the center of gravity where the control would be enfeebled.‡ Under such conditions it seems highly improbable that hydrogen could be retained, and hence, the inference that if the earth had passed through such a history it would be deficient in hydrogen compounds. Not only the atmosphere but the ocean would seem to be put in jeopardy.

But this is by no means the crucial application of the test. The Laplacian hypothesis assumes that the material of the earth and moon was detached from the solar mass as an equatorial ring whose diameter was essentially that of the earth's orbit. Now the gravitation at any point on the surface of such a ring would be very feeble—very much feebler indeed than that on the present surface of the moon where no atmosphere is retained. At the same time, by hypothesis, the temperature of the ring was very high, and this high temperature would only prevail if there were frequent and intense collisions. But the rebound from such intense collisions would carry

the Moon,' by Dr. G. Johnstone Stoney, Royal Dublin Society, 1892, and 'Of the Atmospheres upon Planets and Satellites,' by G. Johnstone Stoney. Trans. Royal Dublin Society, Vol. IV., Part B, Oct., 1897. See also Paper I. above cited, pp. 653–683.

* 'On the Escape of Gases from Planetary Atmospheres according to the Kinetic Theory,' by S. R. Cook. *Astrophysical Journal*, Vol. XI., No. 1, January, 1900, pp. 36–43.

* See reply of Dr. Stoney 'On the Escape of Gases from Planetary Atmospheres according to the Kinetic Theory.' J. G. Johnstone Stoney, *Astrophysical Journal*, p. 251, May, 1900. *Ibid.*, II., June, 1900, p. 357.

† See table, Paper I., above cited, p. 661.

‡ Paper I., pp. 659–661.

the molecules beyond the control of the feeble gravity of the ring, and its dispersion and cooling would seem to be inevitable.* There seems therefore no good ground for supposing that such a ring could maintain either its coherence or its temperature.

But if the ring were dispersed and cooled might it not be reheated to the gaseous condition in subsequently collecting into the globular form? Although a rigorous demonstration is beyond the reach of present mathematical processes, it is possible to make a sufficient approach to a valid conclusion respecting the rate at which such a ring would collect into a globe as to render it improbable that it would heat itself to the requisite temperature or any close approach to it. It is indeed a question whether aggregation would take place at all as the direct result of its own gravitation. Bearing upon this, one of us has attempted to solve a series of specific cases purposely made most favorable for aggregation.† It was assumed, regardless of the probabilities, that an aggregation had already progressed so far as to form a large body having essentially the full gravitative power of the earth and yet it seemed improbable that this body could bring to itself infinitesimal particles from portions of the ring more than 60° distant from itself in heliocentric longitude, unless this were accomplished by other than the simple gravitative force of the earth, the sun and these particles. From this it is concluded that the traditional idea of a hot gaseous ring breaking at some point and gathering into a gaseous globe while still hot enough to maintain the refractory substances of the earth in a gaseous condition, is not tenable, both because of the molecular difficulties and the gravitative incompetencies.

Pursuing this line further, we have inquired whether any single or dominant condensation would take place in a ring of tolerable homogeneity.* Students of the subject are aware that the rings of Saturn are composed of particles of discrete non-gaseous matter and cannot aggregate into satellites because of the differential attraction, or tidal strain, of the planet. They do not illustrate gaseous rings of the Laplacian type on the way to the formation of satellites as once supposed, but quite the reverse. If satellites of equal masses were substituted for them, they would be torn into fragments by the tidal pull of Saturn, and probably redistributed into meteoric rings. The rings appear to represent a state of equilibrium and not a state from which rapid aggregation should naturally proceed, as assumed in the case of the Laplacian rings. The limiting distance within which this power of disruption is exercised by the planet is dependent on its gravitative power and is known as *Roche's limit.* For Saturn it lies a little outside of the outer ring; for the earth, according to G. H. Darwin, it lies about 11,000 miles from the earth's center. We attempted to apply and extend the principles of Roche to cases arising under the nebular hypothesis and in the course of this devised a new criterion of similar nature, applicable to attenuated gases in the form of ellipsoids and rings such as are postulated in the Laplacian hypothesis. For the precise nature of this the reader must be referred to the original paper.† It will suffice here to say that while Roche determined the limits, under assumed conditions, within which disruption would take place, the new criterion assigns the limits, under assumed conditions, within which the aggregation of attenuated or dispersed matter would *not* take place as the result of its own gravitation, in the presence of the superior differential gravitation of the sun. The conclu-

* Paper II., before cited, pp. 658–665.

† Paper III., before cited, pp. 115–117.

* Paper III., above cited, pp. 118–129.

† Paper III., above cited, pp. 122–126.

sion reached by this inquiry was that a Laplacian ring could not have contracted directly into a gaseous globe, and that the nebula out of which the solar system was evolved must have been one of great heterogeneity rather than one of the pronounced homogeneity assumed in the Laplacian hypothesis.

The further question whether the equatorial matter of a spheroid of gas whose rotation was increasing would separate intermittently as rings or go off continuously is not new, but it was thought worth while to reconsider it in the light of modern conceptions of the outer border of an atmosphere or of a globe of gas. This outer border is not now regarded as a defined surface where gravity and 'repulsive force' balance; on the contrary, the outer portion is somewhat like a fountain in which individual molecules are thrown by the rebound from collisions to varying heights, from which they return in elliptical paths, possibly to be thrown back again or to assist in projecting other particles through like paths. There is no theoretical limit to the extent of these excursions short of escape from the control of the main body. The actions of the molecules in this outer portion are therefore more individual and free than those of the denser mass, and in the course of their long free curving paths they may collide in such a way as to become satellites to the main body.

Now the extreme tenuity of the Laplacian nebula seems not to have been considered in connection with ring-formation. One of us has computed that the *average* density of the solar nebula, when extended to the orbit of Neptune, would be 1/191,000,000,000 of that of water.* The tenuity of the extreme outer portion must therefore have been quite beyond the limits of the imagination. In view of this extreme tenuity and the peculiar constitution already cited, it is scarcely possible that there could have been any effective cohesion to prevent the separation of the peripheral portion particle by particle as the individual centrifugal force of each came to equal the centripetal force. It is clear that in a mass of gas densest at the center the centrifugal force would overtake the centripetal force first at the equatorial surface.* The conclusion is therefore that the peripheral matter would have been left behind continuously and that separate rings would not have formed.

Some minor arguments that merely touch the probability of the Laplacian hypothesis may be passed by.†

Arguments of the foregoing class, though they seem entitled to great weight, lack something in rigor, for, at present, exhaustive data cannot be commanded and treated by precise mathematical methods. We, therefore, had recourse to lines of attack of a more mechanical sort. These were found in the relations of mass and momenta. We attempted (1) a comparison of the moment of momentum of the supposed nebular system with the moment of momentum of the actual system, and (2) a study of the ratios of masses to momenta.

1. It is a firmly established law of mechanics that any system of particles rotating about a common axis retains a constant moment of momentum whatever change of form may take place as the result of its own evolution. The evolution of the solar system under the Laplacian hypothesis is such a case. If, therefore, we can restore, theoretically, the supposed nebulous system and compute its moment of momentum, it must be found at all stages the same as at present. The only serious difficulty of the method lies in determining the distribution of density through the postulated nebulous mass. Fortunately this has been at-

* Paper III., above cited, pp. 114.

* Paper III., above cited, pp. 114, 115.

† Paper III., pp. 107–111.

tempted, under some limitations regarding the motions, by some of the ablest of mathematicians and physicists, among whom are Lane, Ritter, G. W. Hill, George H. Darwin, and Lord Kelvin.* The results reached by all are in substantial agreement, though somewhat different analytical methods were followed. The distribution of density computed by Darwin was used in our computations.

The present moment of momentum of the whole system, sun, planets and satellites included, was found to be 22.7666, reckoning the sun as homogeneous, which gives too large results but favors the nebular hypothesis. The unit is a convenient arbitrary one. The moment of momentum of the solar nebula when it reached the orbit of Neptune and had the angular velocity of Neptune, which would be necessary to separate the Neptunian ring, was by computation 4848.055.† These momenta, which should be equal, stand in the ratio of 1 : 213. Furthermore the ratios are different at different stages of the evolution; for example, for the stage just preceding the separation of the earth the ratio of the nebular momentum to the actual momentum was found to be 1 to 1208, and for the stage just before the separation of Mercury, 1 to 754. Larger discrepancies would have been found if the Laplacian hypothesis had not been given the benefit of every doubt as to the structure and of all margins in computation. If for example, the sun be assigned an increase of density toward the center, according to Laplace's law, which is probably near the truth, the last two ratios would be 1 to 1801, and 1 to 1127, instead of the figures given.

For a discussion of the question whether these discrepancies can be due to a radical error in the law of density, the reader must be referred to the original paper.* It can only be stated here that the probable variations from the accepted law of density seem rather more likely to increase the discrepancies than to diminish them, and further that the discrepancies are so enormous that the law must be supposed to quite break down to bring them into harmony. Furthermore it must break down irregularly, for the figures run

Neptunian stage	213
Jovian stage	141
Terrestrial stage	1208
Mercurial stage	754
Present stage	1

To satisfy the laws of mechanics all these should be unity.

2. As the foregoing comparison involves the distribution of density in the supposed gaseous nebula, concerning which there is some doubt, it was obviously desirable to find some mode of comparison which should not involve this factor. This was sought in a comparison between the ratios of the planetary masses to their parent nebula, and the ratios of the planetary momenta to the nebular momenta. In this case the nebular momenta were obtained by adding together the component planetary momenta which they must have equaled under the laws of mechanics. The momenta of the satellites were reckoned in with their respective

* Lane, 'On the Theoretical Temperature of the Sun under the Hypothesis of a Gaseous Mass maintaining its Volume by Internal Heat, and depending on the Laws of Gases as known to Terrestrial Experiments.' *Am. Jour. Sci.*, Vol. XLIX., pp. 56–74, 1870.

Ritter, 'Untersuchen über die Höhe der Atmosphäre und die Constitution gasförmiges Weltkorper,' *Wiedmann's Annalen*, New Series, Vol. LXVI., 1882, p. 166.

G. W. Hill, 'Annals of Mathematics,' Vol. IV., 1888.

Darwin, 'On the Mechanical Condition of a Swarm of Meteorites, and on the Theories of Cosmogony.' *Trans. Phil. Soc.*, 1888.

Kelvin, 'On the Origin and Total Amount of the Sun's Heat,' Popular Lectures and Addresses, 1891. *Constitution of Matter*, pp. 370–429.

† Paper III., pp. 127–128 and Paper II., p. 64.

* Paper II., pp. 65–67.

planets, the estimates of Darwin being used throughout.

Just previous to the supposed separation of the Jovian ring, the moment of momentum of the parent nebula, reckoned from the present moments of momenta of the bodies derived from it, was 14.1816. Now Jupiter has 13.469, or about 95%, of this. But the mass of Jupiter is only 1/1047 of the parent nebula, or less than one-tenth of one per cent. Neglecting for the moment any transfers of momentum that may have taken place afterwards, it appears that, by hypothesis, *the Jovian ring carried away less than one-thousandth of the mass of the nebula, while at the same time it took off 95% of the moment of momentum.* Is such a thing possible in a gaseous spheroid evolving under gaseous laws, or evolving in any form of convective equilibrium? One nineteen-thousandth more of the mass thrown off with an equal proportion of momentum would have left none in the central body!

A similar comparison in the case of the other planets reveals not only very extraordinary ratios but such large and irregular variations in the ratios as could hardly be expected in the systematic evolution of a gaseous body.

To the inquiry whether these discrepancies can be due to subsequent transfers of momentum by tidal friction, the computations of G. H. Darwin have given an emphatic negative; and these are supported by other considerations.*

The general conclusion from these several attempts to test the nebular hypothesis of Laplace is altogether adverse to its tenability. It is equally adverse to any meteoroidal hypothesis which assumes a quasi-gaseous behavior, or an aggregation controlled by the laws of convective equilibrium, as set forth by G. H. Darwin in his memoir 'On the Mechanical Conditions of a Swarm of Meteorites and on Theories of Cosmogony.' The inquiry into the relations of masses and momenta points to an unsymmetrical distribution of matter and energy quite inharmonious with an original spheroidal form of any kind. On the contrary, it seems to indicate that *the origin of the system was such that the outer part acquired all but a trivial part of the momentum while it possessed only a trivial part of the mass.* In specific terms, the outer or planetary part now embraces only about 1/700 of the mass, while it carries more than 97% of the moment of momentum. The sun has no such residual rotatory momentum as to imply that he ever 'threw off' any planets from his equator. If the solar system were converted into a gaseous nebula controlled by Boyle's law and given the existing moment of momentum and allowed to contract, the centrifugal force would not overtake the centripetal until long after the orbit of Mercury had been passed.

The ratios of masses to momenta and the discrepancies of the system clearly have a high value in the construction of a tenable hypothesis, whatever that may prove to be; for they are specific criteria which must be met. In an attempt to construct such a hypothesis, *the matter of the system must be so brought together as to give low mass, high momentum and irregular distribution to the outer part, and high mass, low momentum and sphericity to the central part.* In speculation in this direction the possibility of the initiation of the system by the peripheral collision of a very small nebula upon a large one has seemed worthy of consideration. Assuming that the collision was essentially due to mutual gravitation, the smaller nebula must, from the nature of the case, have had a relatively high velocity, and hence a high ratio of momentum to mass, while the larger nebula may have had little initial rotation, or may even have had a rotation contrary to the present one, which was reversed by the impact, or the recur-

* Paper II., pp. 70–71.

ring series of impacts, of the smaller nebula. So far as we can now see, the most serious difficulty in framing a consistent hypothesis along this line lies in the approximate circularity of the present planetary orbits, but as circularity may result from the combination of a large number of constituents having elliptical orbits, this difficulty may not prove insuperable.

We naturally turn to the heavens for nebulæ whose evolution might give a system of low mass and high momentum in the outer part and high mass and low momentum in the central part. The spiral nebulæ offer the greatest promise of conforming to these demands for they seem to present attenuated outer matter irregularly dispersed and perhaps in relatively high motion, while the central portions are usually denser and seem to possess less momentum relatively, but this is little more than pure conjecture based on their forms, for nothing is positively known of the dynamics of these masses. Professor Keeler has shown by recent photographic researches that spiral nebulæ are the dominant forms among the smaller class. This justifies us in giving them precedence in attempts to find analogies for the origin of our system. This suggestion may really be identical with the preceding, for, in the absence of any knowledge of the origin of spiral nebulæ, it is possible to conjecture that they arose from peripheral collisions of antecedent nebulæ.

T. C. Chamberlin,
F. R. Moulton.
University of Chicago,
July 9, 1900.

THE ILLUSORY DUST DRIFT. A CURIOUS OPTICAL PHENOMENON.

It is of course improbable in the highest degree that the phenomenon here to be described has entirely escaped notice hitherto, but the writer at least is unaware of any existing description of the same. The conditions under which the illusion arises are so easy to fulfill, and the resulting appearance is so odd in many ways, that the readers of Science may be interested in a brief description of the matter. The only 'apparatus' required is a set of black and white lines and a dark background near by. The best results, perhaps, are obtained by using a square yard of common black cloth bearing narrow white lines not more than two millimeters apart. Such cloth may be obtained at any large dry goods store. If now this be hung upon the wall in a strong light, and a square of dull black cardboard be placed above it, or at the side, everything is ready for the observation. Picking out some point near the center of the cloth, let this be fixated steadily for not less than twenty seconds. Then transfer the gaze quickly to the black cardboard, and the illusory dust drift will appear. The appearance is that of *a thin cloud of fine white dust moving across the field of vision.* Or the tiny particles seen may be likened to the motes in a sunbeam, since they much resemble these in density. A steady fixation of the eyes is at no time absolutely essential. They may roam freely over the cloth and then later over the dark background, though the illusion under these circumstances is diminished in strength. The best results are unquestionably secured by as resolute a fixation of the cloth as possible. The necessary *duration of this fixation* seems to depend upon the retinal sensitiveness of the observer. Probably 5 sec. is the minimum for any noticeable after effects, while no advantage seems to be gained in any direction by prolonging the fixation beyond a period of 30 sec. In practice, successive renewals of the illusion may be accomplished by very brief fixations, provided only that the time of the first fixation be moderately long.

The *duration of the illusion* seems also to be an individual matter. One observer can still see traces of the 'dust' after a lapse of 30 sec., while in another case everything had disappeared at the end of 4 sec. Perhaps 10 sec. would be a fair average duration. At about this time the regular after-image is apt to make its appearance, and this tends strongly to drive the illusion away.

But the really interesting point in the matter is the *direction* of the moving drift. This turns out to be directly dependent upon the direction of the lines in the field of fixation. The most general statement of the matter is that, however these lines may lie, the illusory dust currents run in a direction *perpendicular* to them. Quite often, however, it is impossible to speak of the direction as strictly perpendicular, since the course of the drift may be along curved lines, as if a tiny whirlwind had caught up a bit of light, fluffy snow. Or, further—and this is perhaps most often the case—there are secondary currents visible whose directions do not coincide with that of the main stream. Nevertheless some particular direction is almost invariably more prominent than any other, and the statements of various observers show that the direction of the most vivid stream is most decidedly perpendicular to that of the lines. If the lines are vertical, the drift is usually to the *left*, though some subjects see it always to the right. If the lines are horizontal, the tendency to see the drift running *downwards* seems to be slightly more marked. Nearly as many subjects, however, see an upward drift, and quite often currents are seen to run side by side in *both* directions.

If the experiment be so arranged that half the field of fixation is occupied by vertical and the other half by horizontal lines, two clearly separated currents will appear in the illusion with horizontal and vertical directions respectively. Or if the usual field of fixation be divided by a vertical strip of some uniform color, no 'drift' will be seen in that portion of the field corresponding to the strip. If the centre of a set of concentric black circles upon a white ground be fixated, the resulting illusion suggests a confused boiling movement, sometimes running in converging lines towards the center, sometimes passing in diverging lines towards the periphery of the field.

Now the oddity of this illusion consists precisely in this: that without intentional movement either of eyes or of object, there is yet an after-effect in the form of a definite and unmistakable perception of motion. An ordinary after-image of motion requires a previous objective movement of some sort. Here, on the other hand, we can only say that the resulting perception is *as if* there had been a previous and actually perceived motion. And this latter is exactly the case with another peculiarity not directly connected with the illusion itself. After steadily viewing the cloth for say 30 sec., the closely set lines begin to appear beaded. They are no longer straight, but wavy. And even the after-image when it appears presents the same aspect. Now this result is identical with that produced by actual movement of parallel lines across the retina.* Accordingly we have in connection with this illusion, two phenomena that ordinarily follow actual movement. This fact would seem to indicate the direction in which an explanation is to be sought. For while there is no intended movement of the eyes during the fixation of the cloth, there are certainly *impulses* to movement aroused by the various lines about the fixation-point. Every one knows how hard it is to let the eyes come to rest in a field occupied by such lines. Each one of the latter solicits the center of fixation to rest upon it. The impulses to movement are then in directions perpendicular to the lines,

* This has been well described by von Fleischl, Sitzungsber. d. Weiner Acad. 1882, Bd. 86, III. Abth. S. 8.

in other words, in the same directions as the currents of the illusory dust-drift. And, taking all into account, it cannot be very far out of the way to conjecture that the same fundamental factors are at work here as in the familiar cases of the artificial waterfall and the rotating spiral. Mere impulses to movement have taken the place of actual movements in the production of after-effects.

An attempt to obtain the illusion with *monocular* vision is attended with quite surprising results. For even after a full minute's fixation of the cloth, *no 'drift' is to be seen on the black background.* And the result is the same whether both eyes, or the one eye only, be open at the moment of transferring the gaze to the black surface. There is instead an interesting set of phenomena which do not appear in the binocular experiments. Now the illusory dust-masses come to view *during* the fixation. They are not wholly like those above described, but present rather the appearance of fine meshes formed of light gray cobwebby lines. Sometimes these meshes appear to lie slightly in front of the cloth, and if the effort is made to fixate them they temporarily disappear. Movements are by no means wanting, but there is an intermittence about them which the binocular phenomena never show. A closer examination of this net-work character of the illusion reveals the fact that each eye, the closed as well as the open, is contributing to the total effect. This may be readily demonstrated as follows. Let either eye, the *left* for example, be entirely screened from the cloth by a tiny box, or something similar, blackened within, the eye remaining open and free to move. Let the *right* eye fixate the lines. Now while this right eye remains open, the most prominent illusory movements are decidedly those running *perpendicular* to the direction of the lines. This is true no matter how the lines may lie in the field of vision. But if this right eye be closed after a brief fixation, another set of movements is seen projected into the dark field of the covered *left* eye. These movements, though possessing neither vigor nor great vividness, are invariably in the *same* direction as the objective lines. That which moves here is less a dust-cloud than a set of fleecy or worsted-like bands, in the midst of which the 'crossed' after-image of the lines of the cloth soon appears. In addition then to the regular transference of an after-image to the field of the unstimulated eye, we have here the transference also of an illusory after-effect. The illusion is to be sure not wholly the same for the two eyes, but neither are crossed after-images entirely identical in character with the direct after-images. The interesting features then of the monocular experiments are that the illusion appears for the stimulated eye during the period of fixation only, and that the unstimulated eye also presents illusory effects of the same general character as those experienced by the open eye.

It can hardly be said with full certainty that these monocular phenomena have contributed anything decisive towards the explanation of the binocular form of the illusion. Nevertheless there is a point of difference between the two forms which cannot be wholly without meaning. There is, namely, in the monocular experiments a relative absence of the feeling of unrest during the period of fixation. The single eye seems to fixate the chosen point with far less effort. Solicitations to its movement are noticeably absent, and the time of stimulation can be prolonged without discomfort to a point where the binocular stimulation would have become exceedingly disagreeable. Now whether this absence of vivid impulses to movement may be regarded as alone responsible for the difference in the illusion can of course not be affirmed with complete confidence. But it seems probable on the whole that the ultimate explanation of this, as of all after-images of motion, will be somehow formulated in terms of impulses to movement aroused by the particular stimulation that precedes. Perhaps the experiments here recorded may contribute their mite towards this final explanation, if that ever comes.

A. H. PIERCE.
AMHERST COLLEGE.

RAFINESQUE'S WESTERN MINERVA, OR AMERICAN ANNALS OF KNOWLEDGE AND LITERATURE.

IT has been the writer's good fortune to discover in the library of the Academy of Natural Sciences of Philadelphia a copy of Rafinesque's *Western Minerva, or American Annals of Knowledge and Literature*, of which the only information possessed had been taken from the prospectus published as an advertisement in the *Kentucky Reporter* of 1820. The great rarity of the work is explained by its author in his 'A Life of Travel' (1836), page 66, as follows: "Ever since 1821 I had proposed to publish a literary and learned journal, the *Western Minerva;* subscribers were procured, the printer had also made a contract with me, and the first number was printed; when he dared to suppress it, at the request of some secret foes of mine, who probably paid him for it. I only saved three copies of it * * *."

The copy now under observation is a small quarto, with a page measurement of 113x183 millimeters (exclusive of margins). The matter is printed in two columns to the page, and consists of vi + 82 pages, of which the preface and dedication are not double-columned, and pages 81–88 are without doubt original proof sheets, as they are printed on one side only, and bear corrections in ink of typographical and other errors, with such notes as "I must see another proof," etc.

Aside from the rarity of the work, it contains several articles of extreme interest to naturalists, as new names for plants are proposed which have not as yet been noted in synonymy, or else have not been given such an early date in scientific nomenclature. In bringing these matters to the attention of those interested it has seemed advisable to describe the work from the beginning, referring to the non-scientific articles, or the apparently least interesting of these, by title only.

Western Minerva, | *or* | *American Annals* | *of Knowledge and Literature,* | Un peu de tout, | Food for the Mind, | first volume, | for 1821, | Lexington, Kentucky. | Published for the editors, by Thomas Smith, in quarterly num- | bers, four of which form a volume, at $2 per annum. | 1821.

Page ii. Blank.

Page iii. Dedication, "To the Trustees, President, Professors and Tutors of Transylvania University * * *."

Page iv. Blank.

Pages v, vi. Preface [Dated Lexington, January, 1821].

Page 7. Headed with the title as on title-page to the word literature, with the addition of the following: Containing original essays upon Science, the Arts, Literature, and subjects connected with the Civil and Natural history of the Western States. Vol. I. Lexington (Ky.), January, 1820. No. 1.

Pages 7–11. Under the heading Legislation, is Principles of Political Wisdom, * * * Translated from the Greek by Benjamin Franklin.

Pages 11–18. Ethics, or Moral Philosophy. The Moral Decameron * * * Translated from the Greek * * * by Benjamin Franklin.

Pages 18–22. Metaphysics. Theory of the Creation or Emanation of Beings, etc. [Signed, Leibnitz and dated Lexington, October, 1820].

Pages 22–26. Astronomy. Enquiries on the Sidereal, or Upper Spheres, by Professor C. S. Rafinesque. [Among other things the author recognizes three kinds of comets, and brings forward the names *Dromets* and *Tychomets*. For 'revolving stars' he proposes *Geophosies*. Dated, Transylvania University, 22d October, 1820].

Pages 27–29. Meteorology. Letter on Atmospheric Dust, addressed to Governor De Witt Clinton, Albany. [Signed by C. S. Rafinesque, Transylvania University, 1st, October, 1820].

Pages 29–31. Physics. On a New Property in Light, by Captain Forman. With Notes, by C. S. Rafinesque [pp. 29, 30]. Synopsis of some Discoveries on Heat, made in 1818 [pp. 30, 31. Signed M.].

Pages 31–33. Mathematics. On Descriptive Geometry [p. 31. Signed M.]. On Isomerical Numbers, or Common Multiples [pp. 31–33. Signed Archimedes].

Pages 34–37. Chemistry. Synopsis of the Principal Discoveries, etc., made in 1818 [p. 34. Signed M.]. Chemical Art of Converting pure Woody Substances into Gum and Sugar, etc. (Abridged by Professor Rafinesque) [pp. 35–37]. Selection of late European Discoveries in Chemistry [p. 37. Signed M.].

Pages 37–38. Mineralogy. New Mineral Species discovered or ascertained in 1818 [pp. 37, 38. Signed M.]. Notice on the Hydraulic Limestone, by H. De Witt Clinton, Governor of the State of New York, etc., in a letter to Professor Rafinesque. [p. 38. Letter signed by D. C., and dated Albany, September, 1820. The chemical analysis of the limestone is given by Clinton as follows: 35 parts carbonic acid, 25 lime, 15 silex, 16 alumine, 2 water, 1 oxide iron, 6 loess = 100. An appended note by Rafinesque further describes the material.]

Pages 38–40. Original Scientific Intelligence, or Discoveries and Remarks on Natural Sciences; extracted from a letter of Dr. John Torrey, * * * to Professor Rafinesque. [One of the large tuckahoes from the southern States is given the name of *Sclerotium giganteum*, being the largest species known; the substance of the fungus is a new principle for which the name 'Sclerotin' is proposed. The discovery of Datholyte at Paterson, N. J., is recorded, and a new mineral from Schooley's Mountain, N. J., is described and named Siderographite. *Oryzopsis melanocarpa* Muhlenb. and *O. asperifolia* Mich. are differentiated; the latter is not an *Oryzopsis*, and Muhlenberg's species is referred as a synonym to *Milium racemosum* Smith. The letter is signed J. T., and dated N. York, 28th July, 1820.]

Pages 40–43. Botany. Botanical Discoveries made in Kentucky in 1820, by Professor Rafinesque, extracted and translated from a letter to Professor Decandolle of Geneva, * * * [pp. 40–42. Dated Lexington, 1st December, 1820. The genera *Enemion* and *Stylypus* are characterized, the latter evidently the same as *Stylipus* Raf. (1825), the type being *S. vernus*, in both instances. A new genus allied to *Sedum*, but differing in 'having 4 unequal petals and 4 monospermous capsules,' is named *Aectyson*, with *A. sagittatum*, which has 'cylindrical scattered leaves, sagittate at the base, the flowers in a polystachyous umbel, the petals white lanceolate carinate acute, etc., as the type.' The author suggests that this plant is close to *Sedum pulchellum* and the latter may be congeneric. The relationship of *Jeffersonia binata* to the 'family of Berberides' is noted; that *Rhamnus lanceolatus* Pursh, belongs to the genus *Frangula;* that two species of Buck-eye trees are blended under the name of *Pavia pallida*, which he calls *P. ochroleuca* and *P. axillata*, but gives no descriptions. The genus *Cubelium* is named for *Viola concolor*, which makes the date of establishment of the genus 1821, instead of 1824, as has been quoted. He has ascertained more than twenty new species of plants, among which he mentions *Ranunculus mutabilis*, *Trillium revolutum*, *Monarda pratensis*, *Eupatorium serotinum*, *Silene fistulosa*, *Cactus mesocantha*, *Hepatica parviflora*, etc., none of which he describes. The name *Eupatorium serotinum* was used by Michaux in 1803. Other proposed names which have not found their way into synonymy are *Gentiana glauca*, *Pediculars* [sic] *villosa*, *Martynia rotundifolia*, *Veronica connata*, *Zigadenus angulosus*. It is pointed out that *Gentiana amarelloides* Michaux is not the same as *G. quinqueflora* Linné, with which Pursh had confused it. Among some plants received 'from some ladies,' three new ones are mentioned: *Lysimachia* (*Trydinia*) *glauca*, *Gentiana azurea*, and *Trillium reflexum*, the latter 'differing from *T. sessile*, by its petiolated leaves, reflexed calyx and pale purple petals.' Some new names for plants from Missouri are *Gnaphalium nemocladum*, *Melothria alba*, *Asplenium glaucum*, *A. falcatum*, but which are also not described. *Melothria nigra* Raf. 'is common near Natchez.' And the following are recorded from Kentucky presumably for the first time: *Pancratium liriosme* Raf., *Iris brevicaulus* Raf., *Ptelea trifoliata*, *Arenaria divaricata*, *Lobadium trifoliatum* Raf. (*Rhus aromaticum* Ait.), *Triosteum minor*, *Nelumbium pentapetalum*, *Agave virginica*, *Iris cristata*, etc. In a postscript Rafinesque states that a new genus, *Geminaria*, must be formed for *Phyllanthus Carolinianus* Walter and Michaux (called *P. obovatus* by Wildenow, Persoon, Pursh, and Nuttall). Signed C. S. R.].

On the several species of the genus *Clintonia*, addressed to Dr. Samuel L. Mitchell, in a letter dated September 26, 1819 [pp. 42, 43. This is a review of the genus. The author reverses his former opinion that *Dracena borealis* Aiton, and *Convallaria umbellulata* Michaux are synonymous. Four species are recognized as follows: "1. *Sp. Clintonia nutans.* Leaves with ciliate margin, keel smooth: umbel sub-corymbose, pedicels smooth naked nodding unequal, perigone campanulate, sepals oblong sessile subacute.—*Dracena borealis* Ait. Wild. Pers. etc., flowers lerge [sic] yellowish inodorous. New York to Canada on mountains. Var. 1. *Prolifera.* Corymb proliferous.—Var. 2. *Fascicularis,* flowers in separate fascicles. 3. *Obovata.* Leaves nearly obovate. 4. *Dasistema*, scape pubescent. 5. *Macrostema.* Scape longer than the leaves. Var. 6. *Uniflora*, etc."

"2. *Sp. Clintonia podanisia.* Leaves with ciliate margin, keel smooth ; scape pubescent longer than the leaves; umbel erect, pedicels unequal pubescent naked, the longest erect, the others incurved : perigone semi-campanulate, sepals oblong, sessile, acute.—Discovered in July, 1819, on the Laurel ridge in Pennsylvania. Flowers pretty large whitish, inodorous. Var. 1. *Biflora*, with only 2 flowers, the shortest with incurved pedicel, leaves narrow, semicuneate. Var. 2. *Glabrata.* Scape smooth. Var. 3. *Fascicularis.* 2 umbels, the second lateral, each with 3 or 4 flowers. Var. 4. *Phyllostema.* One small lanceolate and acute leaf on the scape."

"3. *S. Clintonia parviflora.* Leaves with pilose margin and keel, scape pubescent, equal to the leaves; umbel creet [sic]* 5–8 flore, pedicels equal, naked pubescent erect, perigone semi-rotate, sepals semi-onguiculated [sic], claws erect, disk oboval obtuse. Discovered in July, 1819, on the top of the Allegheny Mountains in Maryland. Flowers small, perfectly white, nearly inodorous. Var. 1. *Plicata.* Leaves folded falcated. Var. 2. *Abortiva.* Some abortive sessile flowers in the umbel."

"4. *Sp. Cintonia* [sic] *odorata.* Leaves oblong-oval, with ciliate margin and keel ; scape pubescent, umbel erect, pedicels bracteated.—*Convallaria umbellulata* Mx. Pers.,

* Erect?

etc. This character is from the imperfect account of Michaux, who did not mention the shape of the perigone nor sepals ; but the bracteated white fragrant flowers appear to entitle it to be deemed a peculiar species. Native of the Alleghany Mountains. Var. 1. *Punctata.* Flowers with red dots inside." Signed C. S. Rafinesque, and dated Lexington, 10th September, 1819.]

Pages 43–46. Agriculture. Practical Remarks and Results on the Agriculture of the Western States, or on the Cultivation of Corn, Wheat, Hemp and Tobacco in 1820. [Signed Agricola ; dated Fayette county, Ky., 16th November, 1820.]

Pages 47, 48. Manufactures. On the various Manufactures from Flour. [Signed Agricola.]

Pages 49–52. Statistics. Statistical View of the Town of Lexington in Kentucky, in December, 1820 [p. 49. Signed M.]. View of the Public Institutions for Instruction in Spain and the United States [p. 50. Anonymous]. United States of America [p. 51. Signed Mentor]. Remarks on Public Instruction in the State of New York [pp. 51, 52. Signed Mentor].

Pages 53–57. Archæology. Alleghawee Antiquities of Fayette County, Ky., in a letterof Professor Rafinesque to the American Antiquarian Society. [Signed C. S. R. and dated Lexington, 3d January, 1821.]

Pages 57–59. Medicine. On some specific remedies for Mortification, Consumption, Hydrophobia, etc. [pp. 57, 58. Signed D. R.] Notices of Materia Medica, or new medical properties of some American Plants [pp. 58, 59. Medicinal properties are ascribed to *Erythronium albidum, Helonias angustifolia, Helenium autumnale, Evonymus atropurpureus, Euphorbia peploides, Triosteum major, Tr. minor, Sabatia angularis, Gentiana amarelloides.* Rafinesque states that he has found the Bear-grass, *Helonias angustifolia* Michaux to be different from *Helonias* and calls it *Cyanoteris pratensis*. Signed C. S. R.].

Pages 59–60. Discoveries. Selection of late American Discoveries. [Signed W. M.]

Pages 60–80. Literature and Varieties The Sifter.—No. 1. [pp. 60–62. Signed Z.]. The Querist.—No. 1. [pp. 62–64. Signed W. M.]. Female Free-Masonry.—No. 1. [pp. 64, 65. Signed O. I.]. Western Literature. Works published in the Western States in 1820 [pp. 66, 67. Signed W. M.]. The Sphynx.—No. 1. [p. 67. Signed Oedipus]. Polygryphs [p. 67. Signed Constantine]. The Monkeys.—No. 1. [pp. 68, 69. Signed P. Hystrix, M.D.]. Future Epitaphs. By Doctor Porcupine Hystrix, of Cincinnati [pp. 69, 70]. Fragments of Correspondence, containing Fragments of a letter of Mr. Bory St. Vincent * * * to Professor Rafinesque, [dated Bruxelles, 10 August, 1820], 'Annals of Physical Sciences' [p. 71]. Zoological Illustrations, by W. Swainson [pp. 71, 72]. Fragments of a letter to Mr. Bory St. Vincent at Paris * * * on various subjects * * * [Dated Lexington, 7th January, 1821. Rafinesque takes occasion to refer to his antagonists as a "set of unfortunate individuals, who have two eyes; but cannot see; their minds are deprived of the sense of perception; they are astonished and amazed at my discoveries, and are inclined to put them in doubt and even to scoff at them * * * our catfish, eels, shads [sic], sturgeons, etc., are for them mere fish to fill their stomach ! and moreover they are all of European breed, and were carried here by Noah's flood direct from the Thames, the Seine and the Rhine ! —I let them rail to their hearts' content, and I laugh at them * * * " and further he continues, "It is only in Europe that my labors and discoveries may be appreciated: here I am like Bacon and Galileo, somewhat ahead of the age and my neighbors ; * * * " and further, "The *Western Minerva* has been threatened before her birth" Signed C.S. Rafinesque]. Fragments of letters from Lexington. By a Lady [pp. 77–79. Deals with social life in Lexington. Signed Lavinia]. A view of some American Universities and Colleges in 1820 [pp. 79, 80. Signed W. M.]. 6. Transylvania University [p. 80. Signed W. M.].

Pages 81–88. Poetry. The Western Muse, or, Original Poetry. Les Rives de l' Ohio. Poeme en deux chants [pp. 81–82. Signed C. S. R.]. Couplet pour Silvie [p. 83. Signed C. S. R.]. A Melody, My Heart is Gone [p. 83. Signed M. T.]. A Melody. The Man I'll Love [p. 83. Signed Virginia]. La Double Aurore. Ode Anacreontique [pp. 83, 84. Signed C. S. R.]. Le Reveil d' Irma. Ode Anacreontique [p. 84. Signed C. S. R. and dated October, 1819]. L' Enfant et l' Epouse Endormis. Romance [p. 84. Signed C. S. R. and dated October, 1819.] Preceptes Moraux. 1. Le Secret d' etre hereux. 2. Amour et Jealousie [p. 84. Signed C. S. R.]. The Blind Lover [p. 85. Signed Milton]. Lines to Maria. Who asked me if I should like to Love in a Cottage [p. 85. Signed Constantine]. To Silvia [pp. 85, 86. Signed J. R.]. Trifles. By Billy Tickler of Frankford [p. 86. Signed B. T.]. Italian Stanzas. Un Consiglio d'Amore [p. 86. Signed Constantine]. Epigrams [p. 87]. The Elysian Dream. To my Sister [p. 87. Signed Eleonora]. To the Sun. To the Moon. On the Loss of a Friend [p. 88. All three signed Eleanora]. One Word and Only One. To Eliza. To Miss M——, who wished to know what she should read [p. 88. Both signed Oscar].

The copy of the work before me bears the autograph of S. S. Haldeman, one of the early members of the Academy of Natural Sciences of Philadelphia. It is known that Rafinesque advertised a copy for sale at $5.00, stating it to be unique, and it is not unlikely that the present one is that copy, which has been in the Academy's library for many years, although nothing is known of its history.

WM. J. FOX.
ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA.

*THE INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.**

I.—OBJECT AND NATURE OF THE CATALOGUE.

THE object and nature of the Catalogue were defined by means of the following resolutions of the 1896 Conference, which were agreed to *nemine contradicente*. The resolutions are re-numbered, but the original numbers are given in brackets :—

1. [12] That it is desirable to compile and publish by means of some international organization a complete Catalogue of Scientific Literature, arranged according both to subject-matter and to authors' names.

2. [13] That in preparing such a Catalogue regard shall, in the first instance, be had to the requirements of scientific investigators, to the end that these may, by means of the Catalogue, find out most easily what has been published concerning any particular subject of inquiry.

3. [17] That in indexing according to subject-matter regard shall be had, not only to the title (of a paper or book), but also to the nature of the contents.

4. [18] That the Catalogue shall comprise all published original contributions to the branches of science hereinafter mentioned, whether appearing in periodicals or in the publications of Societies, or as independent pamphlets, memoirs or books.

5. [25] That a contribution to science for the purposes of the Catalogue be considered to mean a contribution to the mathematical, physical, or natural sciences, such as, for example, mathematics, astronomy, physics, chemistry, mineralogy, geology, botany, mathematical and physical geogra-

*Scheme of publication approved by the International Conference of 1900.

phy, zoology, anatomy, physiology, general and experimental pathology, experimental psychology and anthropology, to the exclusion of what are sometimes called the applied sciences.

Technical matters of scientific interest shall, however, be included in the Catalogue, but shall be referred to under the appropriate scientific headings. (Rep. Comm., p. 5.)

II.—THE CONTROL AND MANAGEMENT OF THE CATALOGUE.

The control and management of the Catalogue has been provided for by the Conferences of 1896 and 1898 as follows :—

Definitions of the International Council, International Bureau, Regional Bureaus, and International Convention.

[The supreme control over the Catalogue is vested in an International *Convention*, which shall meet at regular intervals.

In the interval between two successive meetings in the Convention, the administration of the Catalogue is vested in an International *Council*, the editing and publication being carried on by a Central International *Bureau*.

The materials out of which the Catalogue is formed are to be furnished to the Central Bureau by *Regional Bureaus*.]

6. That the administration of the Catalogue be entrusted to a representative body, hereinafter called the International Council, the members of which shall be chosen as hereinafter provided.

7. That the final editing and the publication of the Catalogue be entrusted to an organization, hereinafter called the Central International Bureau, under the direction of the International Council.

8. That any country which shall declare its willingness to undertake the task shall be entrusted with the duty of collecting, provisionally classifying, and the transmitting to the Central Bureau, in accordance with rules laid down by the International Council, all the entries belonging to the scientific literature of that country.

[The organizations created for the above purpose are called hereafter Regional Bureaus. Each region in which a Regional Bureau is established, charged with the duty of preparing and transmitting slips to the Central Bureau for the compilation of the catalogue, is called a 'constituent region.' ('98.26.)]

9. In 1905, in 1910, and every tenth year afterwards, an International Convention shall be held in London (in July) to reconsider and, if necessary, revise the regulations for carrying out the work of the catalogue authorized by the International Convention of 1898.

Such an International Convention shall consist of delegates appointed by the respective governments to represent the constituent regions, but no region shall be represented by more than three delegates.

The decisions of an International Convention shall remain in force until the next convention meets. ('98.26.)

Of the International Conventions.

10. The rules of procedure of each International Convention shall be as follows :

(*a*) That English, French, German, and Italian be the official languages of the convention, but that it shall be open for any delegate to address the convention in any other language, provided that he supplies for the *procès verbal* of the convention a written translation of his remarks into one or other of the official languages.

(*b*) That there shall be Secretaries for the English, French, German, and Italian languages. ('98.3.)

(*c*) That the Secretaries, with the help of shorthand reporters, be responsible for the *procès verbal* of the proceedings of the conference in their respective languages. ('98.4.)

(*d*) That each contracting body (as hereinfter defined) shall have a vote in deciding all questions brought before the convention.

Of the International Council.

11. Each Regional Bureau shall appoint one person to serve as a member of a body to be called *The International Council.*

The International Council shall, within the regulations laid down by the International Convention, be the Governing Body of the Catalogue.

The International Council shall appoint its own Chairman and Secretary.

It shall meet in London, once in three years at least, and at such other times as the Chairman, with the concurrence of five other members, may specially appoint.

It shall, subject to the regulations laid down by the Convention, be the supreme authority for the consideration of and decision concerning all matters belonging to the Central Bureau.

It shall make a report of its doings, and submit a balance sheet; copies of which shall be distributed to the several Regional Bureaus, and published in some recognized periodical or periodicals, in each of the constituent regions. ('98.27.)

Each Contracting Body shall have one vote in deciding all questions brought before the Council.

[Pending the constitution of the International Council a Provisional Committee was appointed.]

Of the Central Bureau.

12. The Central Bureau shall be located in London. ('96.24.)

13. The Paid Staff shall consist of—

(i) A General Director who, under the International Council, and in accordance with the regulations of the Convention, shall direct, supervise, and be responsible for all the operations of the Central Bureau.

(ii) Expert Assistants skilled in the literature of various branches of science.

(iii) Such ordinary Clerks as may be necessary.

If the International Council so decide, there shall also be a Consultative Committee, appointed by the International Council, consisting of persons representing the several sciences, and residing in or near London. The Director shall be the Chairman of this committee. (Report of the Royal Society, p. 2.)

Of International Committees of Referees.

14. The following recommendations relating to International Committees of Referees are referred for consideration to the International Council when constituted. ('98.22.)

The International Council shall appoint for each science included in the Catalogue five persons skilled in that science, to form an International Committee of Referees, provided always that the Committee shall be as far as possible representative of the constituent regions. The members shall be appointed in such a way that one retires every year. Occasional vacancies shall be filled up by the Committee itself, subject to the approval of the Chairman of the International Council, and a member thus appointed shall hold office as long as the member whose place he fills would have held office.

It shall be the duty of the Director of the Central Bureau to consult the appropriate Committee or Committees, by correspondence or otherwise, on all questions of classification not provided for by the Catalogue Regulations; or, in cases of doubt, as to the meaning of those Regulations.

In any action touching classification the Director shall be guided by the written decision of a majority of the appropriate Committee, or by a minute if the Committee meets.

Provided always that when any addition to or change of the schedule of classification in any one branch may seem likely to affect the schedule of classification of some other branch or branches, the Committees concerned shall have been consulted; and provided also that in all cases of want of agreement within or between the Committees, or of other difficulty, the matter shall have been referred for decision to the International Council.

All business transacted by the Committees shall be reported by the Director to the International Council at their next ensuing meeting.

Of the Regional Bureaus.

15. In all countries in which, or wherever, a Regional Bureau is established, as contemplated in Regulation 8 (above), the Regional Bureau shall be responsible for the preparation (in accordance with Regulations hereinafter laid down) of the slips requisite for indexing all the scientific literature of the region, whatever be the language in which that literature may appear.

Each Regional Bureau shall transmit such slips to the Central Bureau as rapidly and as frequently as may be found convenient.

In the case of countries in which no Regional Bureau is established, the Central Bureau, failing other arrangements, shall, upon special mandate, endeavor to undertake the work of a Regional Bureau. ('98.24.)

III.—OF THE SUBJECT-MATTER OF THE CATALOGUE.

16. The following branches of science shall be included within the scope of the Catalogue, and shall be indicated as follows by the letters of the alphabet in consecutive order as *Registration Letters.*

A. Mathematics.
B. Mechanics.
C. Physics.
D. Chemistry.
E. Astronomy.
F. Meteorology (including Terrestrial Magnetism).
G. Mineralogy (including Petrology and Crystallography).
H. Geology.
J. Geography (Mathematical and Physical).
K. Paleontology.
L. General Biology.
M. Botany.
N. Zoology.
O. Human Anatomy.
P. Physical Anthropology.
Q. Physiology (including Experimental Psychology, Pharmacology and Experimental Pathology).
R. Bacteriology.

Technical matters of scientific interest shall be included in the Catalogue, but shall be referred to under the appropriate scientific headings. ('98.14 and Rep. Comm., p. 4.)

17. Schedules shall be approved by the International Council, in which the subject-matter of each of the above sciences is grouped under a convenient number of headings, each of which shall be indicated by an appropriate symbol. ('98.11, 15 and 21.)

In the first instance the schedules prepared by the Provisional International Committee shall be adopted, subject to such minor modifications of detail as may be found to be necessary in preparing the first volumes of the Catalogue. The symbols adopted to indicate the headings shall in the first instance be the numbers used for that purpose in those schedules. ('98. 20, and Rep. Comm., p. 5.)

After the publication of the first issue of the Book Catalogue, the Director of the Central Bureau shall consult the Committee of Referees as to the desirability of making changes in the classification, and shall report thereon to the International Council, who shall have power to authorize such changes to be made as they may think expedient. ('98.25.)

IV. OF THE FORM AND ISSUE OF THE CATALOGUE.

18. The International Council is instructed not to issue a Card Catalogue in the first instance, but if the finances permit, a Card Catalogue may be undertaken in future if approved by a special vote of an International Convention.

A Book Catalogue shall be issued in the form of at least one annual volume for each science, but parts may be issued at shorter intervals as the International Council may determine.

The International Council is instructed to proceed to the issue of bi-monthly or quarterly parts only if experience shows that such a course is desirable and financially practicable. (See Rep. Comm., p. 5, and '98.10.)

[Subject to any modifications which the experience of the Central Bureau may show to be desirable, Regulations 19 and 20 are submitted as embodying a scheme of publication.]

19. Since it is desirable to distribute the work of the Central Bureau and the printing of the Catalogue evenly over the entire year, the volumes shall be published in four groups as soon as possible after the first of January, April, July and October respectively.

[As an illustration, the two following schemes have been drawn up for consideration. The first, on the assumption that there will be a smaller number of editors than subjects, distributes the work in cognate subjects over the year.

The second is based on the assumption that there will be a larger staff of editors, so as to enable the volumes on cognate sciences to be published simultaneously.

Scheme 1.—To be published as soon as possible after—

January 1.	A. Mathematics. D. Chemistry. G. Mineralogy. L. General Biology. P. Physical Anthropology.
April 1.	B. Mechanics. H. Geology. M. Botany. Q. Physiology.
July 1.	C. Physics. J. Geography. N. Zoology. R. Bacteriology.
October 1.	E. Astronomy. F. Meteorology. K. Paleontology. O. Human Anatomy.

Scheme 2.—To be published as soon as possible after—

January 1.	A. Mathematics. B. Mechanics. C. Physics. E. Astronomy. F. Meteorology.
April 1.	D. Chemistry. G. Mineralogy. H. Geology. J. Geography.
July 1.	K. Paleontology. L. General Biology. M. Botany. N. Zoology.
October 1.	O. Human Anatomy. P. Physical Anthropology. Q. Physiology. R. Bacteriology.]

20. The titles to be indexed in each volume shall be those (not having been included in a previous volume) received at the Central Bureau from the Regional Bureaus not less than three calendar months, or such shorter period as the Central Bureau may fix, before the first day of the month in which the volume is to be published.

The first group of volumes shall be issued in July, 1901.

The second, third and fourth groups of volumes shall be issued in October, 1901, and in January and April, 1902.

The first literature to be included in the Catalogue is that of January, 1901.

21. The annual volume for each science shall contain :—

(1) The schedule of that science with the authorized registration symbols (see 17 above).

(2) An alphabetical index to the schedule, with the registration symbols attached. (Rep. Comm., p. 5.)

(3) An Authors' Catalogue.

(4) A Subject Catalogue (see 1 above).

22. The schedules and alphabetical Indices shall be printed either in English, French, German, or Italian, under conditions laid down hereafter (see 40 below). (Rep. Comm., p. 5.)

23. The Authors' Catalogue shall be ar-

ranged according to the alphabetical order of the authors' names, the full titles of the the memoirs or books of each author following his name in the order of the registration symbols by which they are indicated.

These titles shall be given in the original language alone if that language be either English, French, German, Italian or Latin.

In the case of other languages, the title shall be translated into English, or such other of the above five languages as may be determined by the Regional Bureau concerned (see 8 and 15 above); but in such case the original title shall be added, either in the original script, or transliterated into Roman script.

The title shall be followed by every necessary reference, including the year of publication, and such other symbols as may be determined. In the case of a separately published book, the place and year of publication, and the number of pages, etc., shall be given. ('98.18 and 25.)

24. The entries in the Subject Catalogue shall be primarily arranged in the order of the appropriate registration symbols in the schedules.

The order of arrangement in the final subdivisions shall in general, be in the alphabetical order of the authors' names, unless the subject demand other treatment. (Rep. Comm., p. 3.)

25. Each entry in the Subject Catalogue shall consist (α) of the author's name ('98.18, i); (β) of the title of the paper, or of a modified title describing the contents of the paper [or that portion of the contents of the paper to which the entry specially refers] better than the title itself (Rep. Comm., p. 4); (γ) of an adequate reference to the journal or other publication. ('98.18, i.)

The titles or modified titles in the Subject Index shall be given only in English, French, German, Italian or Latin.

If the title of the paper is not in one of these languages, the name of the language in which it was published shall be added, but the title or transliterated title in the original language shall be given in the Author's Catalogue only (see 23 above).

V.—OF THE LIST OF JOURNALS, COMMUNICATIONS TO WHICH ARE TO BE CATALOGUED.

26. Each Reginal Bureau shall, before November 30, 1900, furnish to the Central Bureau a list of the Journals, the contents of which it proposes to catalogue. Such Journals to be arranged in a list according to the order of the 17 sciences (see 16 above), which form the subject-matter of the Catalogue.

Journals dealing with science generally are to be placed under a special heading of 'General Science.'

Journals dealing with a limited number of sciences are to be placed under a special heading of 'Several Sciences,' and the sciences with which they deal clearly indicated by the registration letters of Section 16 above.

27. On receipt of the above lists the Central Bureau shall prepare for each of the 17 sciences a list of the Journals (whether special or general) dealing with that science, together with the abbreviated titles which it proposes to use.

Copies of these lists shall be furnished to each of the Regional Bureaus before January 1, 1901, and the abbreviated titles therein given shall alone be used by the Regional Bureaus in the slips (see 15 above) communicated by them to the Central Bureau.

28. A general list of journals indexed in the Catalogue, with the abbreviations to be used as references, shall be issued with the first edition of the Catalogue. A supplement, giving the additions to this list, shall be issued annually with a new edition at the end of five years. (Rep. Comm., p. 5.)

VI.—OF THE PREPARATION OF THE MATERIAL FOR THE CATALOGUE.

29. On and after January 1, 1901, or as soon after that date as the International Council may decide, the Regional Bureaus shall transmit to the Central Bureau the material to be indexed in the Catalogue, arranged on slips.

Unless otherwise ordered by the International Council—

30. The slips shall be of the character prescribed by the Central Bureau, and (except in the case of titles given in languages which do not employ Roman script) the entries thereon shall be either printed, typewritten or legibly written in Roman script.

31. At the head of each slip shall be given the letter and registration number indicating the science and subdivision of that science under which the material referred to on the slip is to be catalogued.

32. Unless the International Council decide otherwise, for each book or memoir to be catalogued, the Regional Bureau shall supply.

1. At least one copy of the entry for the Authors' Index, containing the material prescribed in Section 23 above.

2. At least one copy of each entry for the Subject Index, containing the material prescribed in Section 25 above, and Section 34 below.

The Regional Bureau shall retain duplilates until the volume containing the entries is published.

33. A paper or book shall be entered in the Subject Catalogue in more places than one only when this is rendered desirable by its scientific contents.

No exact limits to the number of entries to be allowed to single papers can at present be fixed. This must be determined by the Central Bureau, after adequate experience. Until such limits are determined, if the Central Bureau is of opinion that in the returns made by any Regional Bureau the numbers of entries to single papers do not correspond to the scientific contents, it shall be its duty to intervene; such intervention, however, to be based, not on individual cases, but upon an average. (Rep. Comm., p. 3.)

34. The International Council is instructed to direct the Central Bureau to aim at keeping the total number of entries in the Authors' and Subject Catalogues within 160,000, and not to exceed 200,000 entries without the permission of the International Convention. (See Appendix I.)

[Lists of species (see 16 above) must be reckoned according to the space occupied, as may be arranged by the Central Bureau.]

The Central Bureau is therefore instructed to reject less important entries, if this step is necessary to keep within the limits above laid down.

VII.—OF THE FINANCES OF THE CATALOGUE.

35. Any Body which establishes a Regional Bureau shall be termed a Contracting Body.

36. The number of copies of the catalogue due to each Contracting Body shall be sent to that Body, or to the corresponding Regional Bureau as such Body may direct, and shall be disposed of by that Body, by gift or sale, at its own discretion.

37. The Provisional Committee referred to at the end of paragraph 11 is instructed to negotiate with the several Contracting Bodies with reference to the sale in their respective regions of copies other than those subscribed for by the Contracting Bodies.

38. The various Contracting Bodies shall distribute the copies of the catalogue due to them in their own constituent regions.

39. Prices shall be fixed for the different volumes by the Central Bureau, and at the request of any Contracting Body, conveyed to the Central Bureau before a date to be fixed by the Central Bureau in any year, different numbers of the different volumes may be supplied to it during that year, pro-

vided always that the total value of such volumes does not exceed the value of the subscriptions received from that Contracting Body.

Unless a request to the contrary is received by the Central Bureau before the date fixed as above provided, the copies of the catalogue supplied in that year to any Contracting Body shall be a specified number of complete sets, *i. e.*, shall contain an equal number of all the volumes allotted to the different sciences.

If any Contracting Body requires a larger number of volumes than are covered by its subscriptions, such volumes may be supplied to it at specified prices to be fixed by the Central Bureau.

40. Any Contracting Body shall have the right to have the schedules and alphabetical indices prefixed to the volumes allotted to it in return for its subscription printed in English, French, German or Italian, as it may prefer.

If no request is made to the contrary, the language of the schedules and indices shall be English. (96.29.)

41. The total number of copies of the Catalogue printed in each year shall be in excess of the number allotted to the different Contracting Bodies to an extent to be fixed by the International Council.

The price at which the volumes are supplied to the Contracting Bodies shall be such as to cover the cost of production of such excess volumes, which, if wanted thereafter by any of the contracting bodies, shall be supplied to them at specified prices.

42. If the sale of the Catalogue or of the additional volumes result, in any year, in a profit, this profit shall be allowed to accumulate, and may be used by the International Council to cover a deficit in any other year; provided always that neither the scope of the Catalogue shall be increased, nor the total number of 200,000 entries exceeded, without the direct permission of the International Convention.

If the Catalogue shows a profit after several years' working, the International Convention shall decide how the profit is to be applied, whether to increase the scope or the bulk of the Book Catalogue, or to the issue of a Card Catalogue.

43. The publication of the Catalogue shall not be undertaken unless the shares taken up cover the estimated cost of the catalogue.

44. The publication, if undertaken, shall be an experiment for five years. All the Contracting Bodies shall agree to continue their subscriptions for five years, and the International Council shall not make contracts extending beyond that period.

THE AMERICAN MICROSCOPICAL SOCIETY.

The twenty-third annual meeting of the Society was held in New York City, June 28, 29 and 30, 1900. The regular sessions were held in Schermerhorn Hall, at Columbia University, and while the attendance was not large there was no lack of interest and of good papers.

The afternoon session of Thursday was confined to reports of the Curator, Secretary and Treasurer, and to a brief business session whereupon the Society adjourned to accompany Section F of the American Association for the Advancement of Science on a trip to the New York Zoological Garden.

In the evening the Society convened at the rooms of the New York Microscopical Society, 64 Madison Avenue, to listen to the annual address of the President, Professor A. M. Bleile, on 'The Detection and Recognition of Blood,' after which the visitors present were tendered an informal reception by the New York Society.

The morning session of Friday, June 29th, was devoted to the reading of papers after a short business meeting. The reading of a tribute to Herbert R. Spencer was the occasion of discussion regarding the Spencer Tolles Fund which had grown to nearly eight hundred dollars. It was the general opinion that a united effort should be made to bring this fund at once to a point where its income would be available for the encouragement of research, and a committee was appointed to carry out the plan.

The Report of the Limnological Commission and papers on various subjects of fresh water biology occupied the afternoon session of Friday, and this program aroused active interest and discussion of the plan offered.

On Saturday morning the reading of papers was concluded, and the final business session closed the meeting. The following officers were elected:

President, Professor C. H. Eigenmann, Bloomington, Ind.; First Vice-President, Chas. M. Vorce, Esq., Cleveland, Ohio; Second Vice-President, Edward Pennock, Philadelphia, Pa.

Election Members of the Executive Committee. Dr. C. A. Kofoid, Urbana, Ill.; John Aspinwall, New York, N. Y.; Dr. A. G. Field, Des Moines, Iowa.

After the installation of the President and the customary resolutions of thanks, the Society adjourned.

The following papers were presented at the meeting in the order given:

'Photographing the Spectra of Colored Fluids,' by Dr. Moses C. White, New Haven, Conn.

'A Method for the Measurement and Demonstration of Size of Minute Bodies,' by Professor Henry B. Ward, Lincoln, Nebr.

'Herbert Spencer's Work,' by Henry R. Howland, Buffalo, N. Y.

'Methods in Embryology,' by Professor S. H. Gage, Ithaca, N. Y.

'A Comparison of the Development of the Larynx in Frogs and Toads,' by Professor S. H. Gage, Ithaca, N. Y.

'On the Distribution of Growths in Surface Water Supplies and the Method of Collecting Samples for Examination,' by Dr. F. S. Hollis, Boston, Mass.

'The Necessity of maintaining a System of Field Work on Surface Water Supplies,' by H. N. Parker, Boston, Mass.

'The Cladocera of Nebraska,' by Dr. Chas. Fordyce, University Place, Nebr.

'Biological Work at the Mount Prospect Laboratory,' by G. C. Whipple, Brooklyn, N. Y.

'Some New Forms in the Cave Fauna,' by Professor C. H. Eigenmann, Bloomington, Ind.

'The Modern Conception of the Structure and Classification of the Desmidiaceae,' by Professor Chas. E. Bessey, Lincoln, Nebr.

'Some North American Hydrachnidae hitherto Undescribed,' by Dr. R. H. Wolcott, Lincoln, Nebr.

'Limnological Studies at Flathead Lake,' by Professor M. J. Elrod, Missoula, Mont.

'Methods of Producing Color and Tone Effects in Lantern Slides' (illustrated by a series of lantern slides), by John Aspinwall, New York, N. Y.

'Some Notes on Bibliographic Methods in Microscopical Work,' by Dr. R. H. Ward, Troy, N. Y.

'A New Ear Fungus of Man,' by Dr. Roscoe Pound, Lincoln, Nebr.

'Methods in Killing and Staining Protozoa,' by Professor M. J. Elrod, Missoula, Mont.

'Synthetic Alcohol as a Fixing Agent for Tissues,' by Dr. T. E. Oertel, Savannah, Ga.

HENRY B. WARD,
Secretary.

SCIENTIFIC BOOKS.

The Birds of Celebes and Neighbouring Islands. By A. B. MEYER and L. W. WIGLESWORTH. Two Volumes. 4to. Berlin, R. Friedländer & Sohn. 1898. Vol. I., pp. i–xxxii, *1–130*, 1–392, pll. 17 (14 colored), and 7 colored maps; Vol. II., pp. 393–962, pll. 28, colored.

Meyer and Wiglesworth's 'Birds of Celebes' marks an era in the history of East India ornithology. It consists of two volumes in quarto, with over eleven hundred pages of text and fifty-two plates and maps, nearly all colored. Although published in Berlin, by the well-known German publishers R. Friedländer & Sohn, it is in excellent idiomatic English, and should thus be especially welcome to English readers. In scope and character it is all that could be desired, being in short just the kind of work we should anticipate from such a source, the senior author especially having many years since attained an enviable prominence among the leading ornithologists of the world.

The field embraced in the present work is the East Indian Archipelago, or 'the island-world from Sumatra to the Solomon Islands and from the Philippines to the Lesser Sundas,' as shown in maps 1 and 2 accompanying the work. This area extends from Lat. 2° N. to 6° S., and from Long. 118° to about 127° E. It thus includes not only Celebes, but 'the Talaut Islands in the north, the Sulu Islands in the east, and the Djampa Group in the south.' It thus extends to the Philippines on the north, to Borneo on the west, and to Papuasia on the east. The Introduction (pp. *1–130*) includes a summary of 'Travel and Literature,' from the visit of Labillardière in 1793 to the expedition of Waterstradt to the Talaut Islands in 1897, with a special list of the literature on Celebes. Next are discussed the 'Seasons and Winds in the East Indian Archipelago' (with maps 3 and 4), in relation to their effect upon the dispersal, distribution, and climatic variation of the birds. This chapter gives a vast amount of information regarding the seasons and general climatic conditions of the various groups of islands from Borneo to New Guinea.

Under the heading 'Migration in the East Indian Archipelago' the general subject of migration is most intelligently considered, as well as the local movements and migration proper of the birds in the various islands. Although there is here a true migration of marked proportions, little as yet appears to be known as to its details, owing to the lack of competent resident observers.

'Variation' is considered under the following five heads: 1. Individual Variation; 2. Geographical Variation; 3. Seasonal Changes; 4. Sexual Differences; 5. Changes depending upon Age. Under 'Geographical Variation' these authors so well express the general concensus of ornithologists respecting the origin of new forms through geographic influences that the following statements seem of sufficient interest to warrant transcription: "Although it is conceivable, and indeed likely, that a new species may sometimes owe its origin to dimorphism * * * it is nevertheless far more certain that the great majority of the peculiar forms of Celebes and the neighboring islands are what are termed geographical species or local races, which have developed their distinctive characters while geographically isolated from one another. In the Celebesian area there are about 150 species of this description now known, not to speak of a large number of partially formed races. The latter are in many respects the most interesting, as they show species in the first stages of their differentiation, and their study holds out the best hope of solving the problem of the origin of species—or at least of the majority of species. The differences seen are often very small, but of a very palpable description * * *. These differences may be due to an inherent tendency in the individuals in question to evolve in a certain direction * * *, or they may be caused by local influences. For some cases the former assumption appears unavoidable; for other cases there is satisfactory evidence of the effect of local influences, though the exact nature of this latter is almost always uncertain; as a rule, probably, both causes operate together, but it very rarely happens that an opinion either way is permissible at present." Following this many instances of 'correlated geographical variation' in size and coloration are cited as characterizing representative forms in different groups of islands.

The subject of 'Sexual Differences,' so prolific of hypotheses, is treated at length, and with admirable conservatism. Eight of the leading 'theories of the origin of secondary sexual characters' are stated and made the subject of comment; six of them are presumed to have been 'actually operative in nature, working alone or more likely in different combinations and degrees.' Reasons are also advanced in support of 'the opinion that mutilations of feathers—and hence of other parts—if repeated for generations— are inherited.'

Under the caption 'Changes dependent upon Age' are discussed such interesting topics as 'ancestral characters,' 'hereditary effects of shelter and exposure,' etc., including the origin of 'racket-feathers' in groups of birds of very diverse affinities.

Some fifty pages are devoted to 'Geographical Distribution,' in which 'Wallace's Line' is considered at length. He leaves the problem undecided, and considers it, in the absence of geological evidence, a 'waste of time to speculate on it with the help of an up-and-down system for the islands and continents, just as required.' The local distribution of the Celebesian birds is presented in great detail by means of a series of tables, etc. Among the novelties of the work is an attempt to estimate the 'value of the affinities of the peculiar species of Celebes'; in other words, it is recognized that the various genera and species are not units of equal value in computing the relationship of the Celebesian avifauna to that of other neighboring countries. The conclusion reached is that the avifauna of Celebes "has far stronger connections with the Philippines than with any of the other neighboring lands, and that the relation of its birds with the Oriental Region is more than twice as strong as with the Australian Region."

The systematic part includes 393 species, and probably about 150 additional subspecies, all treated with the detail, as regards their bibliography, plumage, distribution, life-history, and affinities, that would be expected in a special faunal work of the magnitude and sumptuous character of the present admirable monograph. Dr. Meyer, the senior author, in addition to his high standing as an ornithologist, has the advantage of knowing personally the region to which the present work relates, he having spent three years (1870–73) in Celebes and neighboring islands, collecting much of the material (about 4000 specimens, now in the Dresden Museum) on which the 'Birds of Celebes' is based. He thus had an an opportunity of becoming familiar through actual field work with the geographical and climatic characteristics of the East Indian Archipelago. The numerous colored plates of previously unfigured species are well executed and form a fitting accompaniment to a work of high general excellence, and, moreover, a work which closes an important gap in ornithological literature.

J. A. ALLEN.

A Monograph of Christmas Island. London, British Museum (Nat. History). 1900. Pp. xvi + 337. 8vo. 22 plates, map and cuts.

Christmas Island is a small body of land comprising about 43 square miles, situated in about latitude 10°, 30′ south, nearly 200 miles southwest of the western part of Java, from which it is separated by a depression of the sea floor some 3000 fathoms in depth. Though known to navigators since the middle of the seventeenth century, it has remained uninhabited until very recently, having been explored by Captain Pelham Aldrich R. N., in 1887, and annexed to the British crown in 1888.

It seemed highly desirable that this virgin island should be carefully examined and described by a competent naturalist and geologist before being opened up by Europeans for agricultural and commercial purposes. Accordingly it was arranged with the Trustees of the British Museum that Mr. C. W. Andrews, of the Geological Department, should be granted leave to carry out this exploration, the expenses of which were defrayed by Sir John Murray. Mr. Andrews spent ten months of 1897–98 upon the island and carried out the work with great success. The reports upon the geology and physical conditions of the island in this volume are from his pen, while the various subdivisions of the fauna and flora have been treated by a body of experts to whose descriptions Mr. Andrews has added many notes taken on the spot. The result forms perhaps the most elaborate account of an oceanic island ever published. Sir John Murray, who is interested in the company which has obtained a lease of the island for the purpose of developing its agriculture and deposits of phosphate of lime, intends to watch carefully the effects produced by the immigration of civilized man upon the fauna and flora, and record comparisons in the future for which the present volume will serve as a basis.

The island is of a roughly triangular form with projecting headlands and deep water for the most part close up to the cliffs or the narrow fringing reef which encircles most of the shore. It is in fact the flattish summit of a submarine mountain more than 15,000 feet high which rises some 1200 feet above the sea. The submarine slopes are about two in five, a depth of 6600 feet occurs in less than three miles from the shore and the foot of the mountain within twenty miles. The geological structure in brief, consists of (1) a central core of older volcanics and Eocene or Oligocene limestones; (2) beds of basalt, volcanic ash and thick masses of Orbitoidal (Miocene) limestones enwrapping the core; (3) masses of talus derived mainly from the Miocene rocks and covered by (4) a thick detrital limestone which is derived from the wear of the reefs which cover the higher portion of the island; (5) a raised reef of much later date which covers the foot of the different slopes composed of 4; and finally (6) the late Pleistocene or recent limestones bordering the sea which cling to the base of any of the older formations which may be exposed.

The history of the island seems to include the deposition of several hundred feet of Eocene limestone on a bank with a volcanic basis; the gradual deposition, with slow depression, of masses of Miocene limestone; then a gradual elevation, with oscillations, during which guano was deposited on low atolls, forming the origin of the present masses of phosphate of lime; and finally the attainment of the present status of an elevated limestone island with interbedded volcanic layers surrounded by a narrow fringing reef of coral.

The prevalent wind on the island is the southeast trade, which blows on the average 300 days in the year, with occasional violent northerly storms. As it is the violent rather than the regular winds which transport exotic organisms to isolated islands, it is natural that a large part of the life on the island should be, as it is, intimately connected with the Malaysian types. Nevertheless, there is a recognizable portion of the fauna which is related to that of Ceylon and another to that of Australia, though the latter country is over 900 miles away.

Of the 319 species of animals recorded, about 45 per cent. are regarded as endemic, though a better knowledge of the fauna of Java may diminish this number. Of the plants about 10 per cent. appear to be peculiar to the island. Of both plants and animals not peculiar many have a widespread distribution.

Of the five mammals, two rats and two bats are peculiar to this island; while the shrew is regarded as a variety of a species inhabiting farther India. Thirty-one species of birds are noted, of which seven land birds are endemic. The other vertebrates include one snake (*Typhlops*), three skinks and two geckos, of which one skink and one gecko occur elsewhere. The pelagic species are not counted in the fauna, though three of them visit the island.

Of the landshells fourteen species are enumerated, of which six are local, but all belong to groups widely distributed in the Oriental region. Three out of nine butterflies, ten of the sixty-five moths, six of the nine Microlepidoptera, nine out of eleven Hymenoptera, fifty-six of ninety-four Coleoptera, four out of six Hemiptera, two of the five Neuroptera, fourteen of the twenty-two Orthoptera, three of the twelve Arachnids, and two of the four earth-worms are regarded as peculiar to the island.

The illustrations of the work are first-class, and the authorities of the Museum, Mr. Andrews and Sir John Murray, are to be congratulated on the manner in which the description of the island and the census of its organisms have been carried out. The work will doubtless long serve as a model for such investigations and it is to be hoped is the pioneer of many other monographs of a similar character.

Wm. H. Dall.

THE HUMANITIES IN HORTICULTURE.

The second volume of the 'Cyclopedia of American Horticulture,'* of which the first volume was noticed in Science for June 1st, sustains the high character evidenced in that volume, and is of more than usual interest to the general reader because it happens to include such general topics as greenhouses, herbaceous borders, horticulture, house-plants, labels, landscape-gardening and lawns. These are all so handled as to be interesting and suggestive as well as instructive. Plates 14 (the formal garden at Mt. Vernon), 15 (a modern informal garden), and 16 (a modern cemetery with landscape planting) are especially commendable illustrations.

W. T.

* Bailey, L. H. and Miller, W. *Cyclopedia of American Horticulture*, in four volumes. Vol. 2. E.–M. New York, The Macmillan Company. 1900. $5.00.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for July has for its first article some 'Notes on a Species of Pelomyxa,' by H. V. Wilson, which he names *P. carolinensis*. H. L. Osborn describes at length 'A Remarkable Axolotl from North Dakota,' but omits to give it a name, while W. M. Wheeler makes an important contribution to our knowledge of the driver ants under the caption 'The Female of Eciton Sumichrasti Norton,' with some Notes on the Habits of Texan Ecitons.' James A. G. Rehn discusses 'The Linnæan Genera Myrmecophaga and Didelphis,' concluding that *Myrmecophaga* is the generic name for the tree ant-eater, *M. tetradactyla* and proposing the name *Falcifer* for the great ant-eater, while *Didelphis opossum* is the type of that genus. C. R. Eastman reviews 'Karpinsky's Genus Helicoprion,' and in Part XI. of 'Synopses of North American Invertebrates,' Mary J. Rathbun furnishes the keys for 'The Catometopous or Grapsoid Crabs.' The Reviews are numerous and good.

IN *The Plant World* for July, Alice Carter Cook concludes her series of papers on 'Coffee Growing and Coffee Drinking'; Frank E. McDonald describes 'A Sand Dune Flora of Central Illinois'; C. F. Saunders propounds the query, 'Does the Catch-fly Grass catch Flies?' and E. J. Hill describes the habitat of 'Primula Mistassinica.' A. H. Curtiss discusses 'Some Nameless Plants' of Florida, and C. F. Saunders in the 'Etymology of Columbine,' suggests that it may come from *columbarius*, a dove cote. In the supplement devoted to 'The Families of Flowering Plants,' Charles L. Pollard continues a description of those of the order Farinosæ.

THE June number of the *Ottawa Naturalist* which constitutes No. 3 of Volume XIV. has just been issued by the Ottawa Field-Naturalists' Club. Among the interesting articles it contains we note one by Mr. Frank T. Shutt, chemist to the Dominion Experimental Farms, on 'Soils and the maintenance of their fertility through the growth of legumes.' This paper draws attention to investigations carried on in the fields and laboratories of the Experimental Farm with signal success. The improvement of soils through the growth of legumes has yielded results of the highest value to those who wish to maintain or recover the productiveness of their land. The next paper describes 'The Labrador Flying Squirrel.' Mr. J. D. Sornborger, of Cambridge, Mass., received three specimens of a flying squirrel from Rev. W. W. Perrett, of Makkovik, Labrador. These specimens on examination proved to be distinct from other species and have received the following name, constituting the new sub-species the 'Labrador Flying Squirrel' (*Sciuropteros sabrinus Makkovikensis*). Mr. Walter S. Odell, of Ottawa, contributes an article on 'The two-lined salamander' (*Spelerpes bilineatus*). A short note of the occurrence of the Squid in St. John Harbour, N. B., by Dr. Ami then follows, in which the writer points out that in Sept., 1899, the harbor of St. John and shores adjoining were literally infested with an unprecedentedly large school of squid. The same writer adds a brief note on some British American Echinodermata recorded in the *Challenger* Report on these organisms.

The Canadian Record of Science for January, 1900, which forms No. 3 of Volume VIII., contains the following papers and contributions to science: 'Sir John William Dawson,' by Professor Frank D. Adams, being an able though brief sketch of the life of that great Canadian scientist. It is followed by a letter from Sir J. William Dawson to the corresponding secretary of the Natural History Society and forms the last communication which he gave to that Society which for so many years he upheld by virtue of his own hard work and energies. 'Notes on some of the formations belonging to the Carboniferous system in Eastern Canada,' by H. M. Ami, in which the author discusses some of the problems involved in the classification of the different members of the Carboniferous in Nova Scotia. 'The flora of the Rocky Mountains,' by Rev. Robt. Campbell, M.A., is a contribution to botany of the Canadian Rocky Mountain belt in the broadest acceptation of the term. 'North American Goldenrods,' by Rev. Robt. Campbell, enumerates the different species and varieties of the genus *Solidago* contained in the herbarium of the Natural History

Society Montreal, most of which were obtained in Canada. Two species of the genus *Euthamia*, *E. graminifolia*, the bushy goldenrod, and *E. Caroliniana*, a slender fragrant goldenrod, were added. A review of Dr. Whiteaves's paper on the 'Devonian System in Canada,' by Dr. H. M. Ami, and one on 'Dr. A. E. Barlow's report on the geology and natural resources of the Lake Nipissing and Lake Temiscaming district of Ontario and adjoining portions of Quebec,' by Dr. F. D. Adams are then given. These are followed by a review of Mr. Lambe's 'contributions' to Canadian paleontology, Vol. 4, Pt. 1, on paleozoic corals, by Dr. F. D. Adams, and a synopsis of the annual report of the Geological Survey of Canada, Vol. 10, by Dr. H. M. Ami. The volume concludes with the abstracts of meteorological observations taken at McGill College Observatory, Montreal, for the year 1899.

SOCIETIES AND ACADEMIES.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO. MEETINGS OF THE SPRING QUARTER, 1900.

At the first meeting of the quarter, April 11th, Professor C. B. Davenport read a paper entitled 'Variation in Pectinella' giving the resnlts of a statistical study of the spines of the statoblasts. An abstract of this paper has appeared in an earlier number of Science. The session of April 25th was devoted to a paper by Dr. C. M. Child on 'Abnormalities in Cestodes.' The abnormalities described were selected from a number of specimens of the sheep tape-worm *Moniezia expansa*, most of them occurring in a single specimen in which over a hundred abnormal proglottids were found. The proglottids of this species are very short and wide with a set of genital organs and a pore on each side. The variations range from the simple incomplete separation of proglottids to long spiral proglottids, making seven turns about the body. In many cases very different form-relations occur upon the dorsal and ventral surfaces. The most interesting point in connection with the abnormal segments is the structure of their genital organs. All the organs show a very distinct correlation in form and structure with the form of the proglottid, *i. e.*, a high degree of adaptation. In the incompletely separated segments, conditions are found ranging from the normal, with two complete sets of organs in each segment, through forms where the pores of two proglottids are approximated, or the ducts of two sets of organs are united and open through a common pore, to forms in which a proglottid of nearly double the normal length contains only one set of organs on each side, the different conditions being the result of differing degrees of union between the segments. So close is the correspondence between the form of the proglottid and the structure of the contained organs that, in cases where the form-relations are not alike on dorsal and ventral slides, the genital organs of the dorsal side (vas deferens, vagina and testes) correspond in position with the form-relations of the dorsal side, while the organs situated ventrally (ovary, vitellarium and seminal receptacle) conform to the relations on the ventral side.

In general each particular portion of the genital organs tends to occupy as nearly as possible its normal position with respect to the boundaries of the proglottid in its immediate vicinity. Abnormal form of the proglottid thus causes abnormal position and form in the genital organs, this being sometimes so great as to prevent the organs from being functional.

On May 9th, at the third session of the Club, Mr. E. R. Downing read a paper entitled 'The Spermatogenesis of Hydra,' giving the results of his study of this form.

The principal points of Mr. Downing's paper are as follows: The somatic cells divide amitotically usually, probably always. The spermatogonia arise by amitotic division from the interstitial cells and from the ectoderm cells. They divide mitotically to form the spermatocytes of which there is a single generation. These form the spermatids by mitosis. Preceding each mitotic division the nucleus and cell both increase in size, especially the former. After division the daughter cells become correspondingly smaller. The spermatocytes and spermatids contain six chromosomes, the spermatogonia twelve. In the prophase of mitosis the nuclear reticulum becomes more coarsely meshed, and the chromatin gathers into a number of karyosomes, which later become chromomeres. There are twenty-four of these in the spermatocytes and forty-eight in the spermatogonia. The spireme consists of a single linin thread connecting these chromomeres and forming a spiral which winds about the nucleus just beneath the nuclear membrane. At this stage the nucleus is an ellipsoid of revolution. The spireme makes three complete whorls about the spermatocyte nucleus; but six such whorls are formed in the nucleus of the spermatogonium. The centrosome appears at one side of the nucleus in the plane of its minor axis. The nucleus changes next to an oblate spheroid with the centrosome over the pole. The arcs of the spiremes form meridians. There are, therefore, six such meridians in the spermatocytes and twelve in the spermatogonia. Each has four chromomeres. The spireme now divides at the poles into six and twelve segments respectively. These contract, forming spherical chromosomes at the equater. In the chromosomes the individual chromomeres are indistinguishable. Twenty-four karyosomes are to be made out in the late metaphase of the spermatogonic divisions.

The spermatid nucleus assumes the ellipsoid shape. The cytoplasm immediately about it changes so that it will not stain and a small drop of non-staining material forms at one end of the nucleus. This grows in size as the cytoplasm appears to be altered by the nucleus, absorbed by it and stored. This droplet increases until the nuclear wall which covers it, touches and fuses with the cell wall. A slight projection appears at this point of fusion. It rapidly elongates to make the tail. The droplet which forms the middle piece decreases correspondingly. Meantime the cytoplasm and cell wall have completely disappeared. The centrosome appears within the middle piece. From it anteriorly and posteriorly runs the axial fibre. Within the head of the sperm six dumbbell-shaped bodies are apparent, the persistent chromosomes.

The next meeting was held on May 29th and was devoted to two papers. The first of these 'Variation in *Daphnia hyalina*' was read by Miss M. M. Enteman. The following is a brief abstract:

The shell of *D. hyalina* is extremely variable. For the head crest a range of variation is observed covering forms characteristic for many different species of the genus *Daphnia*. The principal forms described for Europe are a low-rounded and a high-rounded crest, and a crest terminating in a more or less acuminate apex. In America, the species, as far as studied, shows the same variations, and, in addition, a triangular and an extremely recurved crest. Further it is to be noted, that while the European varieties resemble other European species in the form of the shell, the American varieties resemble the American representatives of these species. A study of local variation shows widely differing conditions for related regions, some lakes possessing a single stable form, while others furnish all transitions between extreme varieties. Finally, however, different the summer varieties, they are all represented by a uniformly low-crested form in the winter. The species abounds in our clear northern lakes, and these considerations ought to make it a favorable subject for the determination of environmental influences.

The second paper of the session was a review by Mr. R. H. Johnson of the paper 'On the Reactions of *Daphnia magna* Strauss to Certain Changes in its Environment' by E. Warren (*Quart. Journ. Micr. Sci.*, Vol. XLIII., Pt. 2, 1900).

C. M. CHILD.

THE BOTANICAL CLUB OF CANADA.

THE Botanical Club of Canada was organized by a committee of section four of the Royal Society of Canada, at its meeting in Montreal, May 29, 1891. The object is to promote by concerted local efforts and otherwise the exploration of the flora of every portion of British America, to publish complete lists of the same in local papers as the work goes on, to have these lists collected and carefully examined in order to arrive at a correct knowledge of the precise character of our flora and its geographical distribution, and to carry on systematically seasonal observations on botanical phenomena. The intention is to stimulate with the least possible paraphernalia of constitution or rules, increased activity among botanists in each locality, to create a corps of collecting botanists wherever there may be few or none at present, to encourage the formation of field clubs, to publish lists of local floras in the local press, to conduct from year to year exact phenological observations, etc.; for which purposes the secretaries for the provinces may appoint secretaries for counties or districts, who will be expected, in like manner, to transmit the same impetus to as many as possible in their own spheres of action. Members and secretaries, while carrying out plans of operation which they may find to be promising of success in their particular district, will report as frequently as convenient to the officer under whom they may be immediately acting. Before the end of January, at the latest, reports of the work done within the various provinces during the year ended December the 31st, previous, should be made by the secretaries for the provinces to the general secretary, from which the annual report to the Royal Society shall be principally compiled. By the first of January, therefore, the annual reports of county secretaries and members should be sent in to the secretaries for the provinces.

The annual report of the club for the year May 20, 1898, to May 20, 1899, issued as a part of Vol. V., *Trans Roy. Soc. Can.*, second series, 1899–1900, contains a sketch of the history of 'Phenological Observations in Canada.' It also indicates the progress of botanical research, points out the results obtained in Newfoundland, as well as in Labrador, Prince Edward Island and Nova Scotia. This is followed by 'Observations in a Wild Garden,' by Dr. G. U. Hay, of St. John, New Brunswick, besides notes on work done in Ontario. Professor Macoun's researches in the 'Cryptogamic Flora of Ottawa,' published in *The Ottawa Naturalist*, and Mr. James M. Macoun's 'Contributions from the Herbarium of the Geological Survey of Canada' have been published in *The Canadian Record of Science* and in *The Ottawa Naturalist.*

Full descriptions of the new species of Ottawa Violets were given with excellent plates in *The Ottawa Naturalist* of January, 1899, No. 10, Vol. XII., and reference is also made to *Viola Watsoni* Greene, from Prince Edward Island, and another new species from British Columbia, besides notes on the genera *Antennaria* and *Fragaria.*

From Alberta, Assiniboia and British Columbia reports are also sent in. The teachers of the Department of Public Instruction in Nova Scotia, of which Dr. A. H. MacKay is Superintendent, have been most active in recording phenological observations, from which excellent results were gathered.

The officers of the Botanical Club of Canada for the ensuing year are:

President: John Macoun, M.A., F.L.S., Ottawa.

General Secretary-Treasurer: A. H. MacKay, LL.D., Halifax.

Secretaries for the Several Provinces: Newfoundland, Rev. A. C. Waghorne, Bay of Islands.

Prince Edward Island, Principal John McSwain, Charlottetown.

Nova Scotia, Dr. A. H. MacKay (General Secretary-Treasurer), Halifax.

New Brunswick, George U. Hay, M.A., Ph.B., St. John.

Quebec, Professor D. P. Penhallow, B.Sc., McGill University, Montreal.

Ontario, Principal Wm. Scott., B.A., Normal School, Toronto, Toronto.

Manitoba, Rev. W. A. Burman, B.D., Winnipeg.

Assiniboia, Thomas R. Donnelly, Esq., Pheasant Forks.

Alberta, T. C. Willing, Esq., Olds, N. W. T.

Saskatchewan, Rev. C. W. Bryden, Willoughby.

British Columbia (Mainland), J. K. Henry, B.A., High School, Vancouver.

Vancouver Island, A. J. Pineo, B.A., High School, Victoria.

H. M. A.

Ottawa, June, 1900.

DISCUSSION AND CORRESPONDENCE.

HERMAPHRODITISM AMONG THE DOCOGLOSSA.

In a recent number of Science (ix, 914) Dr. Dall gives a brief account of the newly discovered *Bathysciadium conicum*, in the course of which he remarks that should the animal prove to be really hermaphrodite, it will be the first of the Docoglossa to exhibit this character. This statement is one of Dr. Dall's rare slips; hermaphroditism has already been recorded in the case of *Patella vulgata* (Gemmill, *Anat. Anz.*, xii, 392–4, 1896), and of *Acmæa fragilis* (Willcox, *Jen. Zeitschr.*, xxxii, 441 *et seq.*, 1899). Gemmill believes that this condition in *Patella* is exceptional; in *A. fragilis* it seems to be the normal condition. My reason for this opinion is that the nephridial papilla, which appears to function as a penis, is present in all individuals. This papilla is much larger in *A. fragilis* than in any other *Acmæa* with which I am acquainted, reaching even in the contracted state almost to the edge of the mantle; it is highly muscular and richly provided with large blood sinuses. These facts point to its use as an intromittent organ and if this be conceded, then its universal presence would indicate that every individual is at some time functionally a male.

But however this may be, hermaphroditism either as a regular or as an exceptional condition has already been described in two Docoglossa so that the case of *Bathysciadium* is the third rather than the first recorded instance.

M. A. WILLCOX.

WOOD'S HOLL, MASS., July 25, 1900.

SOME RECENT REPORTS OF FOREIGN MUSEUMS.

THE report of the South African Museum for 1899 notes the completion of a new wing and the opening of a new hall containing a collection of South African rocks, minerals and fossils, while the number of visitors was over 88,000, a gain of 7000 over the previous year. As the appropriation for the Museum is only £2500 the increase of the collections is mainly dependent on gifts, and although a special appropriation of £2000 for the purchase of specimens was made in 1895 this is now exhausted. The progress made is as rapid as could be hoped for under the circumstances, but one can well sympathize with the remark of Mr. Peringuey, in charge of the entomological collections, that the chance of obtaining a thorough representation of the insect fauna of South Africa during the modest span of life usually allotted to man, seems to grow more and more distant.

The Museum has just issued the first part of the second volume of its *Annals* which is devoted to 'A Collection of Slugs from South Africa, with Descriptions of New Species' by Walter E. Collinge. Two well-known species are added to the fauna of South Africa while four species are described as new; *Amalia ponsenbyi*, *Apera natalensis*, *Oopelta flavescens* and *O. granulosa*.

THE report of the Museum of Oxford University for 1899 indicates much progress in educational work and scientific research, as well as in the growth and arrangement of the collections. Three new buildings are in course of construction, the Laboratory of Animal Morphology and Botany, the Pathological Laboratory and the Radcliffe Library. Accessions to the well-known Pitt-Rivers Museum of Ethnology have been the most numerous, although exceeded in number of individual specimens by the insects added to the Hope Collection in charge of Professor Poulton. Our own scientific schools may derive some comfort from the small number of students who seem to have attended many of the courses of lectures, and when Professor Tylor reports a class varying from four to six undergraduates others have little reason to expect more.

PART one of volume three of the *Boletim do Museu Paraense* contains the report of the Director for the fiscal year ending December 31, 1898, together with other papers. The Zoological and Botanical Gardens of Para are included in this report and these, as well as the Museum proper, seem to be in a flourishing condition, while as the visitors during the year numbered somewhat over 75,000, the Museum would seem to be appreciated by the public. The average number of animals in the Garden has been something over 400, representing 130 species, and the Botanic Garden gives a list of 531 species of plants. Attention is called to the fact that the Museum publications represent but a portion of the work of the staff as numerous articles are published in foreign scientific journals.

THE Para Museum has just issued as the first of its memoirs, in quarto form, an account by the Director, Dr. Goeldi, of the exploration of the mortuary vaults constructed by a former race of Indians on the banks of the Rio Cunany, and of the pottery found therein. These vaults or pits were about seven feet deep and half that in diameter, closed above by a granite disk, and at the bottom expanding into a somewhat hemispherical chamber in which the pottery was found. This consisted of a number of vases and flattened dishes of quaint and graceful shapes decorated with elaborate patterns in red. These are admirably depicted in the plates accompanying the memoir and indicate a very degree of art in the part of their designers.

F. A. L.

RECENT PROGRESS IN THE EXAMINATION OF FOODS AND DRUGS.

NEW PLANTS AND DRUGS.

Theodore Peckolt has been continuing his work upon the medicinal and economical plants of Brazil (see *Berichte d. deutsch Pharm. Ges.*). Duyk likewise continues his communications upon Mexican drugs (*Bull. Soc. Pharm. Brux.*, XLIII., and *Bull. Comm.*, XXVIII.). In the consideration of the useful plants of Mexico, J. N. Rose (contribution, U. S. Nat. Herbarium, V., No. IV) treats of the plants of Mexico which are employed for making beverages, seasoning, flavoring, soap, tanning, dyeing as well as those of a strictly medicinal application. J. S. Ward has described some new West African plants in *Pharm. Jour.*, 1900. Several Indian plants have been examined by S. Camphuijo (see *Nederl. Tidjschr. v. Pharm.*, 1899). The arrow poisons of Wagogos are obtained, according to Schellman, by boiling the bark of two trees of the N. O. Euphorbiaceae. *Pilocarpus racemosus*, of the French Antilles, is given by Rocher as a new source of Jaborandi. The leaves contain 0.6 per cent. of pilocarpine and 0.4 per cent. of jaborine. David Hooper has shown that the ancient eastern medicine, *Akakia*, is an astringent extract of an acacia. Schumann has added to our knowledge of the kola exported between Senegal and Angola. All kola seeds are wrapped with the leaves of *Cola cordifolia.* The large seed (nguru) is obtained from *Cola vera;* whereas the small seed (kotofo) is the product of *C. acuminata.* The natives of Bali also employ the seeds of *C. lepidota* and *C. anomala.* According to the investigations of Hendrickx and Coremans, the leaves of *Theobroma kalagua* may be employed as substitutes for kola and cacao.

H. Moeller does not consider that *Rheum Franzenbachii* furnishes any of the commercial rhubarb. Ergot from rice, cultivated by the Indians in Northern Wisconsin, has been examined by R. H. Denniston. Heckel and Schlagdenhauffen find quassin and saponin in the seeds of *Brucea Sumatrana* (N. O. Simarubaceae). These seeds known as kosam seeds are used in China and India for dysentery. Bertrand and Physalix believe the activity to be due to a glucoside which they call kosamin. A new rubber plant of Lagos (*Fantumnia elastica*) is described by Staff. *F. africana* (syn. *Kicksia africana*) does not appear to yield any rubber.

Cathaedulis contains according to Schaer large quantities of caoutchouc, an ethereal oil, alkaloid and tannin. Large edible tubers, called 'native yams' are yielded by *Parsonia paddisoni* (N. O. Apocynaceae). Piralahy rubber (Madagascar) is the product of *Landolphia perieri* H. Jumell. Altamassano has extracted from Coniza, one of the Mexican compositæ, a glucoside which he calls lennesine. Several pecies of Polygala (*P. violacea* St. Hil. and *P. caroeasana* H. B. K.), have been found by Dethan in commercial ipecacuanha. Small jaborandi leaves have been utilized as an adulterant in coca. A new spurious senna has been described by Greenish while Micko has discovered another false cinnamon bark. This is yielded by an unknown species of Cinnamomum, but does not contain the aromatic cinnamon oil.

PLANT CONSTITUENTS.

The investigations of Hesse on the Solanaceous alkaloids show that the active principles of Hyoscyamus are chiefly hyoscyamin with some atropin and hyoscin; while Belladonna root contains an excess of atropine; and Scopola rhizome contains chiefly hyoscin with some atrosin. The two last mentioned bases are found in the scopolamin of commerce.

Hesse finds as a result of an investigation of the various commercial rhubarbs that the Chinese rhubarb contains chrysophanic acid, emodin, rhabarberon and rhein; Austrian rhubarb (*Rheum rhaponticum*) and English rhubarb (*R. palmatum*) contain chrysophanic acid and rhapontin; *Rumex nepalensis* and *R. palustris* contain chrysophanic acid and nepodin; *Rumex obtusifolia* contains chrysophanic acid, nepodin and lopodin.

Tschirch holds that the emodin of aloes and frangula are isomeric and that they can be distinguished by certain color reactions as well as by other tests as shown by the investigations of Oesterle. Tschirch further holds that all methylanthraquinone derivatives, containing one or more oxy-groups, are purgative. The emodins, being tri-oxy-compounds, seem to be the most active. It is suggested that these oxy-derivatives of methylanthraquinone will eventually replace the drugs as aloes, rhubarb, etc., which contain them.

According to H. A. D. Jowett the following alkaloids are present in Jaborandi: pilocarpine, iso-pilocarpine (pilocarpidine of Petit and Polonowski), pilocarpidine (Harnack and Merck). Jaborine does not appear to be present in jaborine leaves and the commercial jaborine is said to be a mixture of these three alkaloids. The alkaloid in Mandragora root is, according to Wentzel, hyoscine ($C_{17}H_{19}NO_3$). In an investigation of the constituents of the wall-flower of the gardens, Reeb has isolated a principle (cheiranthin) resembling digitalis in its physiological action and has found in the seeds an alkaloid (cheirinine) which resembles quinine in its properties. The active principle in Capsicum has been further investigated by Micko, who insists that it is odorless and that the vanilla-like odor ascribed to it by Mörbitz is due to the action of reagents employed. An emetic principle has been isolated by Herberger from melon root and other Cucurbitaceae. The toxic effects of tobacco is ascribed by Thoms to a phenol-like body resembling creosote. A new oily alkaloid ($C_9H_{18}NO$), which is miscible with water, has been isolated by A. Piccinni from pomegranate bark. The daturine in the seeds of *Datura stramonium* L. is considered by J. Thomann to be in the nature of a reserve product. The flowers of *Datura alba* contain hyoscine which Hesse says may supersede the mixture known as scopolamine salt. Investigations seem to show that there is no caffeine in the leaves of any species of Psathura (N. O. Rubiaceae).

Pommerhue has succeeded in making a number of crystalline compounds of the alkaloid, damascenin, extracted by Schneider from *Nigella damascena.* It has been found by H. Meyer that anemonin forms compounds of the maleic and fumaric types. According to Hausman, aspidin is found in *Aspidium spinulosum*, whereas filicic acid is present in *Aspidium filix-mas* and *Athyrium filix fœmina.* A crystalline non-glucosidal principle (gossypol) obobtained from cotton seeds has been examined by Marchlewski. The bitter principle of *Plumiera lancifolia*, investigated by Boorsma and Merck with discordant results, is shown by Franchimont to vary in its M. P., according to the amount of water of crystallization that it possesses. According to Léger, nataloin and homonataloin give a green coloration with sulphuric acid and manganese dioxide or potassium di-chromate ; and a violet color with a solution of soda containing ammonium persulphate. The investigations of Busse seem to indicate that in the unripe vanilla fruit there exists a glucoside, which on treatment with ferments (emulsin) or mineral acids, yields vanillin. The arrow poison of Wakamba (German East Africa) appears to be a glucoside and resembles Arnaud's ouabain. According to the investigations of Hilger, while the coloring principle of saffron is a glucoside, the glucoside, picrocrocin (or saffron bitter) is really a mixture of coloring principles, one of which resembles carotin. Malabar kino has been shown by David Hooper to possess in dry substance over 90 per cent. of tannin. *Hymeneo coubaril* contains 23.8 per cent. catechutannic acid and 2.7 per cent. of catechin. A. G. Perkin has been continuing his studies on the tannin and allied coloring principles of a number of plants. A yellow coloring principle has been isolated by Adrian and Trillat from the digitalin obtained from *Digitalis lutea.* The authors believe it to be different from the digito-flavone of Fleischer. The green and red pigments of *Amanita muscaria* have been subjected to a chemical examination by A. B. Griffiths. A. Nestler believes that the change in color in the ripening of Juniper berries is due to a fungus. The investigations of Charabot on the formation of lavender oil seems to indicate that the oil contained in the flower buds and mature flowers is richer in esters ; whereas in the withered flowers it is the alcohols which preponderate. According to G. Spampani, the oil in olive is produced in the cells of the mesocarp in particular, during the activity of the protoplasm and not on account of the degeneration of the latter. The malic acid in the berries of *Hippophæ rhamnoides* is identical with the acid in *Pyrus aucuparia.* Greshoff has investigated the Pisang wax, the product of an unknown plant of Lower India. The carbohydrates of Tragacanth have been re-investigated by Widstoc and Tollens. Xylose was obtained from the white and arabinose from the brown varieties respectively. Dulcite and not mannite has been found by Hoehnel in *Euonymus atropurpureus.* The same carbohydrate is present in *E. Europæus.*

According to the investigations of J. Grüss, the enzyme in *Penicillium glaucum* acts less powerfully on starch or reserve cellulose, but more energetically on cane sugar, than malt diastase. Semnase, the ferment in leguminous seeds possessing a horny albumin, differs from malt diastase in that its action is less active on starch, but more active on the albumin of the locust bean than diastase. An enzyme (hadromase) has been found by Marshall Ward in the fungi (*Pleurotus pulmonarius* and *Merulius lachrymans*) which destroys the lignified cells of timbers.

HENRY KRAEMER.
PHILADELPHIA COLLEGE OF PHARMACY.

THE PRESIDENT'S ADDRESS BEFORE THE SOCIETY OF CHEMICAL INDUSTRY.

THE annual general meeting of the Society of Chemical Industry took place on July 18th in the lecture theater of the Royal Institution, London. After the transaction of some formal business, including the presentation of the council's report, which showed that the society has now 3459 members, the president, Professsor C. F. Chandler, of Columbia University, delivered his address. According to the abstract in the London *Times* he said that on looking over the addresses of past presidents he found that almost every chemical topic—theoretical, practical and historical—had already been dealt with, and his only hope of being able to say anything that was not already thoroughly familiar rested in the presentation of matters purely American. Treating, first, of chemical and technical education in the United States, he described its beginnings and development, paying special attention to the Columbia School of Mines, afterwards merged in the Columbia University. He ascribed the prompt success of this school to the fact that a fixed and definite progressive course of study was offered for each profession, from which no deviation was allowed. The faculty decided what subjects were necessary for a student to pursue in order to qualify him for his profession, and did not permit him to select the studies which he happened to find most interesting. While Columbia was developing her system of professional education in the applied sciences many other institutions were doing the same. The most striking feature of the American system of higher and technical education was to be found in the fact that most of the institutions had been founded and maintained by liberal gifts of money from wealthy citizens, in many cases made during the donor's lifetime, and that only a small number had been endowed or supported by the public funds. Thus in 1899 over 33 million dollars were given in this way, the largest sum being the 15 million dollars given by Mrs. Leland Stanford, together with large tracts of land, to which as yet no precise value could be attached, to complete the endowment of the Leland Stanford Junior University. There were in all 174 donors, averaging $190,000 each.

Schools of chemistry were now so numerous in the United States that it was almost impossible to state their exact number, but he was safe in saying it was more than 100. In all there were 480 universities and colleges, and 43 technical schools not included in this list. In 1899 it was stated that there were 9784 students pursuing professional courses in the schools of engineering, while 1487 graduated that year, receiving the degree of civil, mechanical, electrical or mining engineer. No one could estimate the value to the industrial development of the United States of such an army of thoroughly trained engineers and chemists. Professor Chandler next referred to what had been done by the chemical societies in benefiting and consolidating the profession in America, and went on to speak about the original investigation carried on by American chemists. He said he could present a long list of valuable contributions to chemical science from American laboratories but it was a regrettable fact that many of their teaching chemists were so overburdened with the duties of instruction and the business of managing large laboratories that they could find but little time for original work.

The president next gave an account of the many important investigations in agricultural chemistry which had been conducted by the chemical division of the United States Agricultural Department, among those mentioned being the practical determination of the number and activity of the nitrifying organisms in soil, the influence of a soil rich in nitrogen on the nitrogen content of a crop, the manufacture of sugar from the sorghum plant, and the comparative study of typical soils of the United States. Of agricultural experiment stations there were now 59, and the 148 chemists connected with them had done a large amount of original investigation in subjects more or less closely allied to agricultural and physiological chemistry. One of the most important purposes of these stations was the protection of the farmer from the cupidity of the dealers in artificial manures, every fertilizer sold being now subjected to careful analysis, of which the results were published from time to time. Many other researches in this branch of chemistry were enumerated in the address, which went on to refer to the work of the United States Geological Survey and to the progress of sanitary chemistry in America. Professor Chandler next gave a long and comprehensive account of the chemical industries of the United States. Beginning with a statement of the raw materials produced by the country, he passed on to speak of the various ways in which they were utilized, and gave an immense amount of information respecting the manufacturing processes in use.

In particular he referred to the progress made in electro-chemistry, and described the methods now adopted for the reduction of aluminium at Niagara and also for the manufacture of carborundum and artificial graphite. Speaking of water gas he described the opposition which had been brought to bear against its introduction for illuminating purposes. The question came before the Health Department of New York, of which he was at the time president, and after careful investigation the department decided that the gas was such an improvement in quality and price while the increased danger as compared with that from old-fashioned coal gas was so slight, that it was not wise to interfere with it. The water gas industry had now taken almost complete possession of the whole country. It seemed safe to say that there were at least 500 gas companies using water gas wholly or in part, and it was estimated that in 1899 three-quarters of the entire consumption, or 52,500 million cubic feet, consisted of carburetted water gas. The price of this was reduced ultimately to $1 per 1000 cubic feet, the average quality being between 26 and 27 candle power, as against bituminous coal gas at $3.75 per 1000, with an illuminating power of 16 or 17 candles.

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*THE JESUP NORTH PACIFIC EXPEDITION.**

MESSRS. WALDEMAR JOCHELSON AND WALDEMAR BOGORAS, of the *Jesup North Pacific Expedition* of the American Museum, have recently started for the northeastern part of Asia, by way of San Francisco and Vladivostok, to continue the work of the Expedition in Siberia.

The region which Messrs. Jochelson and Bogoras are about to visit is situated northeast of the Amoor River. They will study the relations of the native tribes of that area to the inhabitants of the extreme northwestern part of America, and also to the Asiatic races visited by Dr. Laufer, under the auspices of the Museum, and to those living farther west. It is expected that in this manner they will succeed in clearing up much of the racial history of these peoples, and it is hoped that the question as to the relations between the aborigines of America and Asia will be definitely settled. Thus the work of these explorers is part of the general plan of the Jesup North Pacific Expedition, which was organized for the investigation of the relations between the tribes of Asia and America. It is fortunate that this inquiry has been taken up at the present time, since the gold discoveries along the coast of

* From the *American Museum Journal.*

Bering Sea are rapidly changing the conditions of native life; so that within a few years their primitive customs, and perhaps the tribes themselves, will be extinct.

The expedition, after leaving Vladivostok, will go by sea to the northeastern part of the Sea of Okhotsk, where they will establish their winter quarters. Mr. Jochelson expects to spend the winter among the tribes of this coast, part of whom belong to the great Tungus family which inhabits the greater part of Siberia, while others belong to a little-known group of tribes inhabiting the extreme northeastern portion of Asia. Mr. Bogoras will make a long journey by dog-sledge across that part of the country which is north of the peninsula of Kamtchatka, and will spend much of his time among the Chukchee, whose mode of life is quite similar to that of the Eskimo of the Arctic coast of America. Mr. Bogoras is exceptionally well prepared for this work, since he has spent several years among the western Chukchee, who are a nomadic tribe, and subsist on the products of their large herds of reindeer. There is also a small tribe of Eskimo living on the Siberian coast, whom Mr. Bogoras expects to visit.

Mr. Jochelson, after finishing his work on the coast of the Okhotsk Sea, will proceed northwestward, crossing the high mountains which stretch along the coast, on a trail never before visited by white men. Over this route he expects to reach the territory of another isolated tribe, the Yukagheer. On a former expedition Mr. Jochelson visited a western branch of this tribe, whom he reached starting from Irkutsk, in southern Siberia. Owing to the difficulties of the passage, Mr. Jochelson will not return to the coast of the Okhotsk Sea, but will continue his journey westward through Asia, and reach New York by way of Moscow and St. Petersburg.

Both Mr. Jochelson and Mr. Bogoras have carried on a series of most remarkable investigations in Siberia, which are at present being published by the Imperial Academy of Sciences in St. Petersburg. The results of their previous investigations embrace a mass of information on the customs, languages, and folk-tales of the tribes whom they visited.

It may be expected that their journey, which will extend over a period of two years, will result in a series of most interesting additions to the collections of the Museum, and in an important advancement of our knowledge of the peoples of the world.

SCIENTIFIC NOTES AND NEWS.

A MOVEMENT has begun in London to arrange for the erection of a memorial in honor of the late Sir William Flower.

THE Royal Society of Surgeons of England has elected, in connection with the celebration of its centenary, a number of honorary fellows, subject to their attendance at the celebration. These include Dr. I. H. Cameron, Toronto University; Dr. William S. Halsted, Johns Hopkins University; Sir W. H. Hingston, Laval University; Dr. W. W. Keen, Jefferson Medical College; Dr. T. G. Roddick, McGill University; Dr. J. C. Warren, Harvard University, and Dr. R. F. Weir, Columbia University.

PROFESSOR CAMILLO GOLGI, eminent for his researches on the nervous system, has been made a senator of the kingdom of Italy.

PROFESSOR RUDOLF LIPCHITZ, professor of mathematics in the University at Bonn, has been elected a correspondent of the Paris Academy for the section of geometry.

SIR JOHN EVANS has been elected chairman of the Society of Arts, London.

MR. GRANT-OGILVIE, principal of the Heriot-Watt College, has been appointed director of the Museum of Science and Art, Edinburgh.

LORD KELVIN has been elected Master of the Worshipful Company of Clothworkers for the year 1900–1901.

THE steamship *Queen* which arrived at Victoria on August 4th from Alaska had among its passengers W. F. King, the British Alaskan Boundary Commissioner; O. H. Tittman, the American member of the Commission, and O. B. French, assistant. They have concluded their work on White, Chilkoot and Chilkat passes.

DR. W. J. HOLLAND, of the Carnegie Museum, sailed for Europe on August 7th. He will be absent for four weeks.

MR. S. WARD LOPER, curator of the museum of Wesleyan University, has gone to Cape Briton Island under the auspices of the U. S. Geological Survey to study the pre-Cambrian geological formation discovered by Dr. F. S. Mathew.

DR. GEORGE A. DORSEY, curator of anthropology in the Field Columbian Museum, has returned from explorations in the southwest and has gone to Paris as a delegate to the International Congress of Anthropology.

DR. L. E. GRIFFIN, Bruce fellow at the Johns Hopkins University, is at present in Jamaica carrying on researches in animal morphology.

A LETTER has been received in Moscow from Dr. Swen Hedin narrating an excursion into Thibet. He reached Lake Lob Nor on the shores of which he discovered extensive ruins.

THE Madras Government has given an additional grant of 800 rupees to Captain R. H. Elliott for the continuation of his researches on snake venom.

DR. S. A. KNOPF of New York City, has received the prize of 4000 Marks offered by the Tuberculosis Congress at Berlin for the best essay on the subject 'How to Fight Tuberculosis as a Disease of the Masses.'

DR. T. G. BRODIE has been awarded twenty-five guineas from the Goldsmiths' Research Grant of the Royal College of Physicians in recognition of his work on the separation of diphtheria antitoxins.

THE Society of Chemical Industry has awarded its medal to Dr. Edward Schunck for his investigations on natural coloring matters and other researches in technical chemistry.

DR. RUDOLF of Strasburg, has received the Engelmann award (2500 Marks) of the University for geographical exploration.

A BOARD of Medical Officers has been appointed to meet at Camp Columbia, Quemados, Cuba, for the purpose of pursuing scientific investigations with reference to the infectious diseases prevalent on the Island of Cuba. The Board will act under instructions from the Surgeon-General of the Army. The members of the Board are Major Walter Reid, Surgeon U. S. A., and Acting Assistant Surgeons, James Carroll, Aristides Agramonte, and Jesse W. Lazear. It is understood that the Board will devote attention chiefly to the investigation of yellow fever.

THE Berlin Academy of Science has made the following grants: Professor Adolf Schmidt, of Gotha, for the collating and publication of material on terrestrial magnetism, 750 Marks; Dr. Leonhard Schultze, of Jena, for investigations on the heart of invertebrates, 2000 Marks; Professor Emil Ballowitz, of Greifswald, for investigations on the structure of the organs of smell of vertebrates, 800 Marks; Dr. Theodore Boveri, of Würzburg, for experiments in cytology, 500 Marks; Professor Maxime Braun, of Königsberg, for studies on the Trematodea, 970 Marks; Dr. Paul Kuckuck, of Heligoland, for investigations on the development of Phæosporeæ, 400 Marks; Dr. Wilhelm Solomon, of Heidelberg for his geological and mineralogical investigations in the Adamello mountains, 1000 Marks; Professor Alexander Tornquist, of Strasburg, for the publication of his work on the mountains of Vicenza, 1100 Marks; Professor Alfred Voltzkow, of Strasburg, for the drawings of his work on the development of the crocodile, 1000 Marks; Professor Johannes Walther, of Jena, for the publication of his work on deserts, 1000 Marks.

WE regret to note that Dr. Gustav Born, professor of anatomy at the University at Breslau, died on July 6th, aged 49 years, and that Dr. Wiltheiss, associate professor of mathematics at Halle, died on July 9th.

THE contest of the will of the late Dr. Thomas W. Evans has been compromised by the payment of $800,000 to the heirs. This, it is said, will leave about $3,000,000 for the dental college and museum to be established at Philadelphia.

SURGEON-GENERAL STERNBERG states that 100 additional medical officers are wanted by the government for duty in the Philippines and in China.

THE schooner *Grampus*, of the U. S. Fish Commission, which returned on August 1st from a trip to the tile fishing grounds, reports a greater abundance of tile fish than ever before.

THE British Medical Association held its 68th annual meeting at Ipswich from the 31st of July to the 3d of August, under the presidency of Dr. John Ward Cousins. According to the announcement of the program the general addresses were as follows: Address in Medicine, by Philip Henry Pye-Smith, M.D., F.R.S., consulting physician, Guy's Hospital; Address in Surgery, by Frederick Treves, surgeon extraordinary to H.M. the Queen; Address in Obstetrics, by William J. Smyly, examiner in midwifery, Royal College of Physicians, Ireland. The Association met in thirteen sections, including one on navy, army and ambulance, established this year for the first time. This section and the one on tropical diseases have especially full programs.

The Swiss Scientific Society holds its 83d annual meeting at Thusis on the 2d, 3d and 4th of September. With it meet the Geological, Botanical and Zoological Societies of Switzerland. A number of interesting excursions have been arranged in connection with the meeting to which foreign men of science are invited.

The International Society of the Psychical Institute is the name of a society recently established in Paris for the purpose of obtaining money to establish a museum and library at Paris, to encourage research, to publish a journal, etc. The society wishes to cover the whole field of psychology, but will apparently especially concern itself with those more or less occult phenomena in which societies for psychical research have chiefly interested themselves. The American members of the committee endorsing the program are Professor J. Mark Baldwin, Professor J. Howard Gore and Mr. Elmer Gates.

Mr. J. E. S. Moore, of the Royal College of Science, London, has returned from Central Africa, where he has been engaged in explorations under the auspices of the Royal Geographical Society. Among the results of his expedition are the ascent of one of the Mountains of the Moon, about 16,500 feet high; the more exact location of Lake Tanganyika, which is said to be fifty miles west of its ascribed position, and the discovery that Kivu is a much larger lake than had been supposed.

The construction of the vessel designed by Mr. W. E. Smith, one of the chief constructors to the Admiralty, for the National Antarctic Expedition is, as we have already noted, in active progess at the yard of the Dundee Shipbuilders' Company. The *Times* states that the ship, which is to be named the *Discovery*, is to be barque-rigged and to have three decks. Accommodation for those on board will be provided under the upper deck. The stem will be of the ice-breaker type, with strong fortifications. The length of the vessel between perpendiculars is 172 feet; beam, 34 feet; and depth, 19 feet. The timbers are of oak, dowelled and bolted together, and the keel, deadwoods, the stem, and the stem-posts are also of oak. The planking is of American elm and pitch pine, and the inside beams are of oak. With the object of avoiding the magnetic influence of iron on the scientific instruments on board, it has been decided that for a considerable radius amidships the knees and fastenings shall be of naval brass. In case the *Discovery* should have to winter in the ice, a heavy wagon cloth awning of strong woollen felt is to be provided. The fittings and equipment of the vessel will be of the most modern type. The engines, which are to indicate 450-horse power, are to be constructed by Messrs. Gourlay Brothers and Co., Dundee.

We learn from the London *Times* that another addition to the numerous existing processes designed to prevent decay in wood is now being introduced into England by the Xylosote Company in the shape of the Hasselmann system. In this the timber to be treated is enclosed in a cylindrical vessel in which a fairly high vacuum can be produced by a suitable air-pump. When the sap has been drawn out of the pores under the diminished pressure a solution of metallic and mineral salts is allowed to flow into the vessel, and the wood is steeped in this for some hours under a certain pressure of steam and at a temperature of about 130 degrees C. Then, after being dried, it is ready for use. The impregnating liquid is a solution of the sulphates of copper and iron, whose preservative properties are generally acknowledged, together with some aluminium, potassium, and magnesium salts. The inventor of the process maintains that the copper destroys any germs of decay that may be present, while the iron combines with the cellulose, or woody fiber, to form a compound which is insoluble in water and hence cannot be washed out by the action of rain. The salts in this way are made to permeate the substance of the wood, and are not merely deposited mechanically as minute crystals in the pores by the evaporation of the solvent. It is claimed for the process, which, apart from the drying, takes about four hours, that it greatly reduces the inflammability of the wood, enables it to take a brilliant polish, and increases the hardness of certain soft woods to such an extent as to render them available for purposes to which formerly they could not be applied. Another advantage attributed to it is that it saves the expense of seasoning in the ordinary way, since perfectly green wood after treatment neither shrinks nor warps. The process appears already to have gained considerable recognition abroad; thus it is stated that the Bavarian State railways and post-office have contracted to have all their sleepers and poles up to 1905 treated by it, while the Swedish Government has adopted the system and ordered 600,000 sleepers preserved by its use.

Figures have been issued in regard to immigration at the port of New York for the year ending June 30th, from which it appears that 341,711 emigrants passed through the port during the year. This is an increase of nearly 100,000 over last year. The following table shows the arrivals of some of the races:

Race.	1898–'99.	1899–1900.
Bohemian and Moravian	1,935	2,329
Croatian and Slavonian	6,837	8,906
English	4,258	4,346
Finnish	3,349	6,783
French	2,013	1,956
German	21,219	23,382
Greek	2,351	3,734
Hebrew	27,086	44,520
Irish	21,637	25,200
Italian (northern)	13,008	16,690
Italian (southern)	63,481	82,329
Lithuanian	6,033	9,170
Magyar	4,517	11,351
Polish	26,015	36,855
Ruthenian	1,371	2,653
Scandinavian	16,034	22,847
Slovak	13,550	25,392

The Sydney correspondent of the *British Medical Journal* describes the various means which have been taken to prevent the spread of the plague in that city. As soon as a case is notified to the Board of Health a medical officer is despatched, and if he confirms the diagnosis the patient is at once removed to the quarantine hospital as well as all the other residents in the house. The house is then thoroughly disinfected under the supervision of the Board of Health officials. The contacts are kept in quarantine for five days, and if no suspicious cases occur among them they are then allowed to return to their home. Large areas of the city have been quarantined in succession, all the residents are kept inside the barriers and not allowed to go to their business. Each house is then cleaned and disinfected; all sanitary fittings and drains attended to, and all rubbish removed and burnt. This process has now been gone through in a large part of the city, so that it is probably cleaner than it has been for a very long time. There has also been an organized crusade against rats, and a capitation grant of 6d. is now made for all rats brought to the incinerator. This has resulted in a very large number of these animals being destroyed. The Government has decided to resume a large part of the wharfage in Darling Harbor and practically rebuild it with stone facings. Citizens' Vigilance Committees have also been organized in the various electoral districts of the city and suburbs, with the object of assisting the Board of Health and the local municipal councils in cleaning and disinfecting. Hitherto in every case all the contacts have been removed to quarantine ground, but it is now recognized that this is not necessary in every case, and at a special meeting of the New South Wales Branch of the British Medical Association it was resolved to appoint a deputation to wait upon the Premier to point out that in the opinion of the members of the Branch the indiscriminate quarantining of contacts is unnecessary.

A great deal of important scientific investigation says the London *Times* is being carried on at different marine biological stations around the coast. Admirable work has been done at the Marine Biological Laboratory at

Plymouth, and it is much to be regretted tha more liberal funds cannot be provided to allow the Association to carry on its investigations on a more extended scale. The purpose of that Association was stated by the late Professor Huxley to be that of "establishing and maintaining laboratories on the coasts of the United Kingdom where accurate researches may be carried on leading to the improvement of zoological and botanical science and to an increase of our knowledge as regards the food, life conditions, and habits of British food-fishes and molluscs." At the request of the Devon Sea Fisheries Committee, Mr. W. Garstang, of the Plymouth Association, some time since prepared a report on the efficacy of the methods heretofore adopted in sea fishery hatchers, together with an account of recent experimental work bearing upon the rearing of the fry of sea fishes, and of the bearings of experiments upon practical proposals for artificially increasing the stock of fish on depleted fishing grounds. In the report in question Mr. Garstang expresses the opinion that in no case has the utility of any past operations in sea fish hatching been satisfactorily demonstrated. He contends that the methods heretofore adopted and the scale upon which they have been carried out have been altogether inadequate for the production of the results which in all cases have been aimed at, and which in several cases have been claimed to have been attained. He believes that no useful results can be expected to accrue from sea fish hatcheries until the problem of feeding and rearing the fry to a more advanced stage has been satisfactorily solved. While he considers that there is a fair prospect of an early solution of this difficulty, he advises that in the meantime, the most useful measure to adopt would be to promote the artificial propagation of sea fishes on board the fishing boats during the spawning season, fertilized eggs to be returned at once to the sea. Mr. Garstang alludes to the sea fish hatcheries which claim to have conducted their operations on more than an experimental scale. These include the cod fish hatcheries in Norway, the United States Fish Commission's hatcheries at Woods Holl and Gloucester, and the Newfoundland Government hatchery at Dildo Island. In regard to the latter he says: "The inconsistency of the claims made for the work of this hatchery have been exposed by Mr. Fryer in several recent reports of the inspectors of fisheries, so that, beyond expressing my conviction of the fairness and accuracy of his criticisms, I need not dwell upon the merits of this case."

UNIVERSITY AND EDUCATIONAL NEWS.

Sir James Chance has given £50,000 to the endowment fund of the University of Birmingham, which now amounts to about $2,000,000.

The residuary estate of the late James Garland is left to Harvard University in the event of no grandchildren surviving. The contingency is perhaps rather remote, but the amount of money involved is said to be several million dollars.

It appears that one of the nephews of the late Jonas Clark is taking steps to dispute the will leaving money to Clark University, but an appeal has not yet been made to the court.

The new building for the first chemical laboratory of the University of Berlin was dedicated on July 14th. Professor Emil Fischer, director of the laboratory, made an address after which the new building was thrown open for inspection. There were present the minister of instruction, the rector of the University, the permanent secretary of the Academy of Sciences and a number of delegates from foreign universities.

Dr. Charles A. Kofoid, assistant professor of zoology in the University of Illinois and superintendent of the Natural History Survey of that State, has been appointed assistant professor of histology and embryology in the University of California to begin work January 1, 1901.

Mr. R. S. Clay, late lecturer in physics at the Birkbeck Institution, has been appointed principal of the Wandsworth Technical Institute, London.

Dr. Edwin Klebs has resigned the professorship of pathology in the Rush Medical College of the University of Chicago.

SCIENCE

Friday, August 17, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*WORK OF THE U. S. GEOLOGICAL SURVEY, 1899–1900.**

Appropriations.—The appropriations for the U. S. Geological Survey for the fiscal year 1899–1900 amounted initially to the sum of $817,190. During the winter of 1900 additional appropriations were made for special purposes, making the total amount available for the year $889,740.89. For the fiscal year 1900–1901 the appropriations passed by the last Congress amount to $969,690, there having been important increases in response to public demand for work. The Division of Mineral Resources receives an advance of $20,000, raising its appropriation to $50,000; the Division of Hydrography receives $100,000 in lieu of $50,000 last year, and the demand for geologic work is recognized by an increase of that appropriation from $110,000 to $150,000.

Topographic Work.—The federal appropriation for topographic work remained the same as during the past year, namely $240,000, except that there was a considerable increase for the Alaskan surveys, the amount available for geologic and topographic investigations being $60,000. The list of states co-operating was increased by the addition of Ohio, the legislature having provided $25,000 for topographic mapping.

From the appropriation for surveying the forest reserves an allotment of $90,000 was

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made by the director for the continuation of topographic mapping within and adjacent to the reserves, including triangulation and spirit leveling and the marking of certain reserve boundaries, and under this allotment operations will be conducted in the following reserves: Bighorn, Black Hills, Lewis and Clarke, Flathead, Uinta, Gila River, Prescott, Sierra, Pine Mountain and Zaca Lake, San Jacinto, San Bernardino, Washington, and Mount Rainier.

The general topographic operations contemplated for the present year include the mapping of about 40,000 square miles. This area is distributed through about eighty-five quadrangles on two scales, and twenty-seven States.

The topographic mapping is progressing steadily if slowly, as is indicated by the fact that for the past five years the percentage of surveyed area has been increased each year approximately one per cent. the total percentage at the end of the fiscal year 1900 being twenty-eight. If this rate is not increased it will require over seventy years to complete the survey of the United States, to say nothing of the colonial acquisitions, but it is hoped that this period may be reduced. That the present rate of appropriation is inadequate is evident from the fact that in making up the plans for the current fiscal year it was necessary to deny applications for work covering about as much territory as that for which surveys were provided. These applications came, not only from the officers of the surveys engaged in geologic, hydrographic, and forestry investigations, but from the business interests of the country generally.

Geologic Work.—During the spring of 1900 the Director has planned, with the approval of the Secretary of the Interior, an important reorganization of the Geologic Branch. In order that the significance of this step should be appreciated in all its bearings, it is desirable briefly to review the history of the administrative and scientific control within the Survey. In the First Annual Report, Mr. King set forth a plan of organization based on grand geographic and geologic provinces. The work being then restricted to the national domain west of the 101st meridian, four divisions were established, that of the Rocky Mountains under Emmons, that of the Colorado under Dutton, that of the Great Basin under Gilbert, and of the Pacific under Hague. Each of these divisions corresponded to a province within which the geological phenomena had a certain unity of history and character, and it was wisely argued that the work in each should be directed by a geologist familiar with the special problems of the area entrusted to him. At the same time, the limited appropriations of the Survey and the adopted policy of surveying the most important mining districts led to a concentration of effort upon Leadville, Eureka, and the Comstock Lode, so that initially comparatively little progress was made in solving the broad geologic problems presented to each division. The principal contributions which the West yielded to the philosophy of the science were made by the surveys through whose consolidation the Geological Survey was created. With the growth of the Survey and the addition to its corps of many of the leading minds in American geology, more numerous geographic divisions were established and their limits became more artificial. Thus in the Sixth Annual Report we find enumerated, in addition to the ones first established, the Division of Glacial Geology (Chamberlin), the Division of Volcanic Geology (Dutton), the Division of the Crystalline Schists of the Appalachian and Lake Superior Regions (Pumpelly and Irving respectively), the Appalachian Region (Gilbert), and the Yellowstone Park (Hague). As divisions became more numerous and restricted, the administrative machinery became more complex, and the opportunities afforded the geologists in charge to study broad problems became more and more limited. Finally, it was found that the administrative relations were not only difficult but expensive, since they involved the maintenance of independent offices and clerks, and in the interests of economy and efficiency the system of geographic divisions was abolished in 1893. In its place was substituted an organization by parties, of which there were at first twenty and subsequently nearly double that number, each acting independently of the other except in so far as they were all brought into co-operation through the Director and the Assistant in Geology. Broad co-ordination of scientific work was for the time being subordinated to the accumulation of facts, especially in the form of geologic maps, rather than to the consideration of philosophic problems. After six years of this activity in the working out of special problems, the time has come for broader supervision and co-ordination of work, and to this end the following appointments have been made: Geo. F. Becker, Geologist in charge of Physical and Chemical Research; T. C. Chamberlin, Geologist in charge of all Pleistocene Geology; S. F. Emmons, Geologist in charge of Investigation of Metaliferous Ores; C. Willard Hayes, Geologist in charge of Investigation of Non-Metaliferous Economic Deposits; T. W. Stanton, Paleontologist in charge of Paleontology; C. R. Van Hise, Geologist in Charge of Pre-Cambrian and Metamorphic Geology; Bailey Willis (Assistant in Geology to the Director), Geologist in charge of Areal Geology.

The field of supervision of each geologist in charge is coextensive with the work of the Geological Survey and relates to all parties engaged in work connected with his special subject. His assistance in field or office work may appropriately be offered or invited. His opinion is to be considered authoritative in subjects under his supervision, and his approval to any report may be required. This authority, however, is restricted to the scientific aspects of the work. Administrative direction remains as heretofore wholly in the hands of the director, and the work of the survey will proceed after the manner which has been found successful—of authorization of plans of operations after full consideration and conference upon estimates submitted by geologists in charge of parties.

Under the organization now adopted, each geologist is at liberty to make full use of the facts which he observes within his field of operations, the degree of supervision exerted by the geologist in charge of any particular subject to be duly credited in an appropriate manner. For the geologists in charge the plan affords an opportunity to study a special subject in all its aspects throughout the field of operations of the survey, either directly by personal observation or by conference with associates. This opportunity is unequaled in both multiplicity and magnitude of the phenomena presented to each specialist.

In Science, Volume X., No. 242, August 18, 1899, was given a somewhat detailed account of the geologic work of the survey. The following notes refer to extension of the work there described:

In the Atlantic Coastal Plain work in the Mesozoic and later formations has been carried out in the Cape Cod district (Shaler), and in Maryland and Virginia (W. B. Clark).

The investigations of Bascom, Dale, Emerson, Hobbs, Keith, Kemp, Mathews, Williams, and Wolff in the pre-Cambrian and metamorphic rocks of the Appalachian Range have been continued at various points from New England to Georgia.

In the belt of folded Paleozoic strata of the Appalachian Valley and Allegheny ranges no field work is now in progress except incidentally to the investigation of the Coal Measures. Folios of the Geologic Atlas, for which the data have been on hand, have recently been advanced to publication. The detailed surveys of the Appalachian coal field (Campbell and David White) have, however, been pushed energetically in West Virginia, Kentucky, and Ohio.

In the Lake Superior region the studies of the iron-bearing ranges begun under Irving are approaching completion. The work on the Vermillion Range, Minnesota (Van Hise and others) is nearly accomplished, and the Mesabi district alone remains to be surveyed. The results of the survey of the Menominee district are published as a folio of the Geologic Atlas.

The long continued investigation of the glaciated region is now bearing fruit in a series of monographs by Mr. Leverett, one of them having been published, another being ready for the printer, and the work on others being planned.

The geology of Indian Territory is being studied in prosecution of surveys having for their initial purpose the determination of the stratigraphy and structure of the coal field. Three folios of the Geological Atlas have been prepared (Taff), and data for others are accumulating.

The Black Hills has long been a center of much geologic interest. Detailed stratigraphic surveys of the Paleozoic and Mesozoic formations around all but the northern portion of the Hills have been very successfully and carefully carried out (Darton), and there has resulted a report to be published in the twenty-first Annual, in which the facts of stratigraphy and structure are set forth with much detail and clearness.

The detailed investigation of the Spearfish and Sturgis quadrangles in the vicinity of Deadwood has resulted in an important contribution to our knowledge of laccolithic intrusions (Jaggar), and the mining districts have been carefully examined (Emmons and Iriving).

The investigating of the Butte, Montana, mining district has been facilitated by the workings opened up during litigation, and advantage has been taken of this fact to study that interesting region exhaustively. A survey was also made of the Elkhorn district (Emmons and Weed). In connection with the examination of the copper deposits in general, those of the Appalachian Range have also been visited.

In the San Juan Mountains of Colorado the work begun several years ago continues with accuracy and energy, and in connection with it special investigations have been made of the Silverton and Rico mining districts (Cross, Spencer, and Ransome). The publication of the Telluride folio marks a departure in the character of the Geologic Atlas, in as much as it contains a detailed record of the geologic facts (Cross, Purington).

In the Great Basin province, southern Nevada was traversed during a prolonged reconnaissance, the purpose of which was to secure data for the geologic map of the United States (Spurr).

Where the Rio Grande traverses the mountain region of Texas it flows through a grand canyon, from which several parties, including those of the Boundary Surveys, turned back after vain efforts to traverse it. In the autumn of the past year this canyon was successfully studied and an important contribution to the geology of western Texas was thus made (Hill).

In Washington the surveys of the Cascade Range were extended by the survey of the Mount Stuart quadrangle and the partial survey of the Snoqualmie quadrangle and the Tacoma folio was completed and published (Willis, Smith, and Mendenhall).

In Oregon work in the Roseburg and

Coos Bay quadrangles having been completed and the reports advanced to publication, surveys were continued in the Port Orford quadrangle, covering the southwestern portion of the Klamath Mountains (Diller).

In the Sierra Nevada and adjacent ranges, a survey was made of the Silver Peak quadrangle, Nevada, and additional work was done on the Yosemite and Mount Lyell quadrangles, California, in preparation for final survey (Turner).

In the vicinity of San Francisco the study of the Coast Ranges was continued, and material prepared for publication as folios (Lawson). A reconnaissance was made of the Santa Lucia Range from Monterey to San Luis Obispo (Willis, Fairbanks).

Alaska.—In the autumn of 1899 all the Alaskan parties returned after having successfully accomplished the tasks laid out for them without serious accident. Messrs. Peters and Brooks had traversed the northern foothills of the St. Elias Range, finding one of the most interesting features of the region to be a recently abandoned broad valley, trending northwest and southeast, across which the present streams now flow. The geology of the region, including formations from the ancient metamorphic schists to Tertiary deposits and associated igneous rocks, was studied along the route of progress, and occurrences of copper on the northern side of the Wrangel Alps were located. North of the Yukon a traverse was carried from Eagle City to the Koyukuk, and the headwaters of that stream, far beyond the Arctic Circle, were explored by Mr. Schrader. The general surface of the Yukon plateau was traced into the summits of high mountain ranges, and the distribution of the various geologic formations along the route made out. The reports of these expeditions are included in the Twenty-first Annual. Late in the autumn both Schrader and Brooks, hearing of the Cape Nome excitement, proceeded to Nome, and there, in spite of the wintry season, gathered data for a report, which was published as a special document during the winter. Plans for Alaskan work during the current fiscal year were matured as early as Congressional action permitted, and at the present time Schrader, Spencer and Gerdine are entering the Copper River region to undertake a detailed topographic and geologic survey of the Chettyna district, while Messrs. Barnard, Peters, Brooks and Mendenhall, with a strong corps of assistants, are *en route* in the Coast Survey steamer *Pathfinder* to Golofnin Bay, to undertake a topographic and geologic survey of the Seward Peninsula, of which Nome is now the center of interest. In the preparation and execution of these plans the Coast and Geodetic Survey and the Geological Survey have cordially co-operated to the great advantage and economy of the work.

Hydrographic Work.—This branch of the Geological Survey is making systematic examination of the water resources of the United States, considering water as a mineral of fundamental economic importance. Not only are the fluctuations of surface streams being investigated, but the occurrence of water underground, especially where reached by deep or artesian wells. During the past year this work has attracted widespread public attention, and the demand for data, both published and in process of completion, has been notable. This has come from all parts of the United States, but especially from the Appalachian region where water powers are being utilized, and from the arid region of the far West, where agricultural development depends upon irrigation. Engineers and investigators appreciate the importance of accurate data concerning the flow of streams and their fluctuations from season to season and from year to year. The recent disaster to the dam at Austin, Texas, which cost, with its accessories, one and one-half millions of dollars, has lent tragic emphasis to this point.

In 1888 the Director of the Geological Survey was authorized by Congress to examine the arid region with reference to reclamation of agricultural lands by irrigation. The initial appropriation of $100,000, which was raised to $250,000 in 1889, was discontinued for several years thereafter; but having been restored in part, it has been from time to time increased, and of the $100,000 appropriated for hydrographic work a large part is expended in ascertaining the service of streams, in surveying reservoir sites, and determining the possibilities and cost of flood water storage in the West.

During the present year a notable increase in hydrographic work is being made in the State of New York in co-operation with the office of the State Engineer and Surveyor. Streams tributary to the Mohawk and upper Hudson are being measured, the data having importance not only in water power development, but also in consideration of the quantity available for the deep waterway across the State. In the Southern Appalachian region the amount of water coming from the area which it is proposed to include within a National Park is being ascertained, this work being in addition to systematic measurement of streams entering the Atlantic Ocean, such for example as the Delaware, Susquehanna, Potomac, James and Savannah. Various important streams are also being measured along the head waters of the Ohio and Mississippi.

Through co-operation of the Hydrographic and Geologic branches, the investigation of artesian water conditions about Black Hills is being continued, and plans are under consideration for similar studies of southern California and of the southern coastal plain of the Atlantic and Gulf States.

Bailey Willis.

SECOND REPORT OF THE COMMITTEE OF THE GERMAN CHEMICAL SOCIETY ON ATOMIC WEIGHTS.

In 1897 a committee was appointed by the German Chemical Society to consider the subject of atomic weights with especial reference to securing uniformity for practical analytical work. As a matter of fact two distinct standards were in use, $H = 1$ and $O = 16$, and as the latest determinations of Morley had reduced the atomic weight of oxygen to 15.87 ($H = 1$) it made a decided difference in the atomic weights of the heavier elements which standard was used. This committee consisted of Landolt, Ostwald and Seubert, and to the surprise of many, their first report in November, 1898, was unanimous in favor of the standard $O = 16$. Up to this time Seubert himself had used and advocated $H = 1$ and the same was true of most German chemists. The two chief arguments for $O = 16$ are: (1) many of the atomic weights are determined with reference to oxygen or readily reduced to oxygen standard with little error, while reduction to hydrogen brings in a new and unnecessary error, and necessitates a recalculation and new table every time the hydrogen-oxygen ratio is corrected, as it has been several times in the past few years; (2) if $O = 16$ is taken, a large number of most frequently used atomic weights approximate very closely to whole numbers, simplifying calculations.

A second point advocated by the committee in the first report was that only so many figures should be given in the atomic weight of an element, as that the last figure should be correct within half a unit. In this report the suggestion was made of the desirability of international agreement, and a little later the society directed its committee to invite the co-operation of the chief scientific bodies of the world who might be specially interested in chemistry. Favorable responses were made and twenty different committees appointed. There were from America two (American Chemical Society and American Academy of Arts and Sciences) ; Belgium, two ; Germany, five ; England, one ; Holland, one ; Japan, one ; Italy, one ; Austro-Hungary, four; Russia, one; Sweden, one; Switzerland, one. Denmark, France and Norway alone made no response to the overtures. Altogether there were fifty-six members of the international committee.

On December 15, 1899, a circular was addressed to these members asking for opinions upon three points :

1. Shall O = 16 be adopted as the standard of atomic weights?

2. To how many decimal places shall the atomic weights be given?

3. Is a smaller permanent committee on atomic weights desirable?

Forty-nine replies were received. As regards the standard, forty favored O = 16, seven H = 1, while Cannizzaro desired both, and Fresenius preferring O = 16 would be satisfied with either. It is interesting to note that six of the votes for H = 1 were German, six other Germans voting for O = 16. The only other vote for H = 1 was from Professor Mallet. Of the other Americans Richards, Gibbs, Remsen and Smith, voted for O = 16, while Clarke and Morley made no reply.

On the second point opinions differed so widely, that the committee was constrained to leave the decision to the smaller permanent international committee to be later appointed. Of the Americans, Richards, Gibbs and Remsen favor stating one figure which is uncertain by more than a unit, while Smith and Mallet would give only so many decimals that the last figure should be correct to less than half a unit.

Views were practically unanimous in favor of a small permanent committee and the committee recommended the appointment of a permanent committee of three chemists who have given special attention to the subject of atomic weights.

In conclusion the committee express a desire to receive the opinions of chemists outside of the international committee as to their preferences for the standard. Such replies should be sent before November 15th, to Professor Landolt, Berlin, N. W. Bunsenstrasse, 1.

In this connection it is interesting to note that the work of this committee is the final outcome of an agitation which was begun in this country in 1889 by Dr. F. P. Venable in a paper published in the *Journal of Analytical Chemistry* (**3** : 48), and which was taken up the following year by Dr. Brauner, of Prague, and very warmly discussed before the German Chemical Society by Ostwald, V. Meyer, Seubert and Brauner. At that time Meyer and Seubert advocated H = 1 for the standard and this view has had many supporters in Germany but few elsewhere. The argument in its favor seems to be the impossibility from a didactic standpoint of taking *sixteen* as a *unit*. In his first paper Venable pointed out clearly the distinction between the idea of *standard* and *unit*, showing that a standard need not be a unit, and this view has been generally adopted by most chemists outside of Germany.

J. L. H.

THE FOSSIL SHELLS OF THE LOS ANGELES TUNNEL CLAYS.

THE detection of a species of *Radiolites*, by Mr. Homer Hamlin, in the clays perforated in the course of drifting the Third Street tunnel in the city of Los Angeles is a discovery of noteworthy importance by reason of its bearing upon the question of the geologic age of the region hereabout. These clays, which will be more fully described by Mr. Hamlin or myself when the tunnel excavation is completed, have yielded other interesting forms—many examples of a new species of *Lima* (*L. Hamlini* Dall) of unusual size and of quite distinct characteristics, as well as two of the three species of '*Plagiostoma*,' described and figured by the late Dr. John B. Trask in the Proc. California Acad. Sciences in 1856. They were assigned by him to 'the Cretaceous rocks of Los Angeles' County. These are listed (? as one and the same species) under the head of 'Tertiary and Quaternary Mollusca,' in Dr. J. G. Cooper's 'Catalogue of Californian Fossils,'* as *Pecten Pedroanus* Trask, Mioc.—'San Pedro,' with the remark, 'may be an *Aucella* and Cretaceous.'

Dall † refers to Trask's species '*P. Pedroanus* + *P. annulatus*' and '*P. truncata*' in his comments on the Pectens of the West Coast in the 'Tertiary Fauna of Florida,' qualifiedly referring them to the Miocene. Dr. Cooper in his prefatory remarks to the Catalogue above quoted, says, "It must be remarked that the exact geological position of many fossils in the Tertiary and Cretaceous strata is still unsettled, there not being such distinct divisions between them in California as in some other countries."

The Hippuritidæ which Woodward placed in his Section B, Family VIII. of the Conchifera, includes the genera, *Hippurites* and *Radiolites* of Lamarck as well as other more or less closely related groups, in the Order *Rudistes* of Lamarck. As these forms are but little known, it may be well to quote Woodward's description of *Radiolites*, which is based on examples from the chalk beds of Europe, of which he has given figures in his Manual :‡ "Shell inversely conical, biconic, or cylindrical; valves dissimilar in structure; internal margins smooth or finely striated, simple, continuous; ligamental inflection very narrow, dividing the deep and rugose cartilage pits; *lower valve* with a thick outer layer often foliaceous; its cavity deep and straight, with two dental sockets and lateral muscular impressions; *upper valve,* flat or conical with a central umbo; outer layer thin radiated; umbonal cavity inclined towards the ligament; teeth angular, striated, supporting curved and subequal muscular processes."

The examples from the tunnel clays consist of the remains of four individuals, being portions of the lower valves of two, and the nearly perfect upper valve of a third. The fourth, also an upper valve, is in still better condition; all are bedded in the clay, but are too fragile to admit of separation from the matrix. The upper valve is discoidal in shape and moderately convex, the umbo central; the surface in the third example somewhat rugose, and exhibiting concentric growth-ridges and radiating sculpture; its diameter is about 47 mm., or an inch and three quarters. In the fourth (upper valve) the concentric sculpture is absent and the radiating feature more conspicuous; this consists of closely set thread-like ridges, which extend from the umbo to the extreme periphery of the valve, projecting somewhat beyond, forming a pectinated edge or margin, as seen in certain finely sculptured Limpets and Siphonarias. The diameter of this last is slightly in excess of the other, being 49 mm. These upper valves were found at points so distant from the lower valves, as to warrant the conclusion that they were never connected, but are parts of separate individuals.

But little is left of the lower valves; their concavity is shown by the casts in the clay. Portions of the curious foliaceous lamellæ remain intact, so that their character and relation to the outer surface of said valve is indicated.

The umbos are central or nearly so, in

* Seventh Ann. Rep. State Mineralogist of Cal., 1887–88, pp. 221–308.

† Trans. Wagner Free Inst. Part IV., Vol. III., p. 705, April, 1898.

‡ Recent and Fossil Shells. Ed., 1880, pp. 446–7.

both upper and under valves, and the concavity of the latter is about twice as great as the convexity of the upper valve.

Perhaps a better idea of the form and other features of the lower valve may be understood by the following: Take an elevated limpet-shell that is circular, or nearly so in marginal outline with an apex that is central. Cover the outside with closely-set radiating lamellæ much elevated or produced, standing up at a right angle from the surface of the shell; the lamellæ as thin as writing paper and projecting beyond the extreme margin or periphery. Now reverse this limpet-shell so that the concavity will be uppermost, and press it firmly into a rather compact clayey sea-bed and the general aspect of the lower valve of the *Radiolite* we are considering, when *in situ* will be seen, and the function of these external lamellæ suggested. Whether the lamellæ, which are so closely set that the interspaces are about as narrow as the lamellæ are thin, are of calcareous or chitinous matter is a point for discussion. The texture of their surfaces, character of fracture, slight prismatic reflections and the fact that they are apparently less perishable than the other portions, favor the latter or chitinous character.

There are no indications tending to show that the lamellæ were inclosed by an exterior wall, which would make them septæ or partitions, and the inter-spaces cells. The lamellar as well as the other exposed parts are much discolored by ferro-oxide making it difficult to determine, so far as color is involved, whether the lamellæ are of a calcareous or ligamentary substance, though the latter is suggested.

"The foliations of the lower valve," of *R. fleuriausus*, according to Woodward, "are sometimes as thin as paper and several inches wide."

In the remains from the tunnel these are about five-eighths of an inch in width.

In the related *Chamadæ* we find the various species fix their shells (lower valves), by means of a limey deposit, the same as the substance of their shells, to *hard* surfaces, cobble-stones, boulders, fixed rock, coral-fronds and to the surfaces of other shells. The grain, texture and lack of density in the ordinary clays are not favorable to attachment by a *flat* or horizontal calcareous deposit. The remarkable lamellar development in the *Radiolites* whether epidermidal or calcareous, meets this character of sea-bed, by the projection of the lamellæ into the clay, and furnishes an interesting illustration of special adaptation to peculiarities of habitat or station, for by these lamellæ which cover the entire surface (presumably) of the under valve, fixity is obtained in an effective manner.

These forms probably lived where patches of the sea-bed of a clayey character prevailed, at a depth below the agitation of the water during storms.

For a more thorough determination of the characters of this *Radiolite*, which for convenience may be called *R. Hamlini*, further material is awaited. While the conditions of the specimens thus far obtained does not admit of a complete diagnosis, they are nevertheless sufficient to indicate the generic relations. These tunnel fossils point to relationship between the clays in which they occur, and the Walalla,* Mendocino county beds visited by Dr. G. F. Becker. The Walalla beds were found to contain fragments of the rare *Coralliochama Orcutti* White, previously discovered by Mr. C. R. Orcutt at Todos Santos Bay, Lower California. *C. Orcutti* occurs at La Jolla, San Diego county, where specimens were collected some years ago by Mr. Hamlin.

Dr. Becker's Walalla collection included other species as well as *Coralliochama*, and

* Walalla is the Indian name: Gualalla, the U. S. Postoffice title.

these, in connection with the Orcutt and La Jolla localities, to quote the comments of Dr. White,* 'seem to represent the fauna of a cretaceous formation, which has not heretofore been recognized,' though Dr. Trask's assignment of his species of '*Plagiostoma*' to the Cretaceous should be borne in mind.

Examples of *Radiolites Hamlini* have also been met with in the Broadway tunnel excavation. These tunnels which are several blocks apart, run in different directions; that on the line of Third street being an east-and-west tunnel, while the Broadway, follows a northerly and southerly course; both penetrate the high ridge overlooking the city, known as Fort Hill, the site of the earthworks thrown up by Fremont at the time of the 'conquest' of Southern California.

The clays excavated on Shatto Heights in the preparation of a site for the Shatto mansion on Orange street are perhaps of a later age than those of the tunnels. The Shatto clays contained shells and sharks' teeth; the former were not saved by Mr. Shatto, and were covered up by the graders just before my visit in 1887.

Rob't E. C. Stearns.

Los Angeles, June 12, 1900.

THE ROYAL COLLEGE OF SURGEONS.†

This year marks the completion of a century since the Royal College of Surgeons received its Royal charter of incorporation from George III.; and the centenary of that event, which, to be precise, happened March 22, 1800, has just been celebrated. But, though the present corporation can only claim a lifetime of 100 years, it can count its descent in a direct line back to a much more remote antiquity, for a Guild of Surgeons, whether technically incorporated or not, seems to have been in existence in London more than six centuries ago, and to have existed ever since in one form or another. In 1368 mention occurs of the surgeons as a distinct body; and the license without which they could not, apparently, practice in the City of London enjoins upon them, among other things, that they serve the people well and truly in their cures and only charge reasonable fees. The association of barbers and surgeons also dates from the same early times, and seems to have been a result of ecclesiastical influence. It would naturally be supposed that the Church would be the repository of the surgical knowledge of the day, just as it was of other science and art, and such indeed appears to have been the case until Innocent III. forbade priests to perform surgical operations, on the ground that the Church 'abhoret a sanguine.' But the prohibition was not sufficient to make them give up all attempts to control surgical practice, and when they were shut off from employing direct methods they had recourse to indirect ones. They began to 'push' the barbers—a class of men of whose services they had, of course, constant need, and who were in the habit of performing minor surgical operations—and gradually erected them into a fellowship of barber-surgeons, a Barbers' Guild being referred to as early as 1308 in the records of the City of London. As may easily be imagined, the cry of unqualified practitioners soon made itself heard, and various regulations were asked for to prevent unskilful persons from practicing the art both by the surgeons and by the better sort of barber-surgeons, who evidently became differentiated from the others who were barbers pure and simple.

Among the most important events in the history of this Guild of Surgeons were its combination with the physicians and the incorporation, about 1423, of the two into one distinct body to control all persons en-

* Vide Bulletins 15 and 18, U. S. Geological Survey.

† From the London *Times*.

gaged in the practice of medicine and surgery. This commonalty of physicians and surgeons drew up elaborate regulations for the guidance of its members in the exercise of their profession, and sought to improve the standard of their knowledge by requiring them to pass examinations before they could be admitted to practice; but it cannot have been a great success, for in a few years all traces of it disappear, and the previous chaotic state of affairs is re-established. About 1423 the Guild of Surgeons is heard of as a separate body making stringent professional regulations for its members, while in 1461 the Barbers' Company obtained a Royal Charter, in which various rights and privileges concerning the mystery or craft of surgery were confirmed to it, without any mention of the Guild of Surgeons. But the latter was far from extinct. In 1492 it obtained a grant of arms, the original of which is still in the Barbers-hall, and in 1511 it was concerned in getting an Act passed which restricted any one from practicing in the City of London or within seven miles of it unless examined and approved by the Bishop of London, or the Dean of St. Paul's assisted by professional assessors. But the surgeons got little thanks for their pains; they were accused of 'minding only their own lucres' and vexing 'divers honest persons, as well men as women, whom God hath endued with that knowledge of the nature, kind and operation of certain herbs, roots and waters,' and in the end the statute was so modified as to be practically, abrogated. In 1540 the surgeons and the barbers were united into one company, both, as the Act says, exercising surgery, but the latter incorporated, the former not. The privileges granted to the barbers by their charter were confirmed and others were added—*e. g.*, they were allowed to take the 'Bodyes of ffoure condemned persons yerely for Anatomies,' while it was also enacted that "no manner of person within the City of London, suburbs and one mile therefrom using any barbery shall occupy any surgery, letting of blood, or any other thing belonging to surgery except drawing of teeth, nor any practising of surgery shall use any shaving." This shows clearly that, though the company was a union of the two bodies, the two professions were not merged together. At the same time constant efforts were evidently needed to keep them distinct, and the surgeon part of the company was often troubled by attempts on the part of the barbers to usurp its functions. But the arrangement subsisted for over 200 years, in spite of monetary embarrassments, difficulties in coping with quackery, and disputes with the physicians, who objected to the surgeons giving internal medicines and declined to consult with them. In time, however, it began to be felt that the 'union of the surgeons with the persons altogether ignorant of the science or faculty of surgery (as the Barbers are)' was not an advantage, and in 1684 a petition was presented for the dissolution of the company. This was unsuccessful, and it was not till 1745 that a Bill to make the barbers of London and the surgeons of London separate and distinct corporations was agreed to by Parliament and received the Royal assent.

The proper style of the new corporation was the 'Masters, Governors, and Commonality of the Art and Science of Surgery.' It consisted of 21 assistants, of whom one was master, two were wardens, and ten were examiners. The master and wardens were elected annually; but the assistants were appointed for life from the freemen. One of the first acts of the company, which was not able to take anything from the Barber-surgeons in the way of hall, books, or plate, was to lease a piece of ground in the Old Bailey—conveniently contiguous to Newgate—and erect a lecture theater thereon. This was first used in 1751, the meetings of the court of assistants being meanwhile held in the hall of the Stationers' Company. The company started in favorable circumstances; its fees were lower than was possible in the old company, and its members were relieved from the onerous and expensive civic offices which formerly they were liable to serve. But for all that it did not prosper very greatly the cause being to a large extent mismanagement. At first its available funds were scanty, and in 1780 it was nearly insolvent. A new clerk, who was engaged at this time, affected a great change in this respect; but as the finances improved new methods of spending money were discovered—*e. g.*, assistants attending punctually at the meetings of the court were rewarded with half-a-crown, later with half-a-guinea, while meetings of the courts, in some years held almost once a fortnight, were supplemented with expensive dinners at the sole cost of the company. Yet while this sort of thing was going on the lecture theater was without lectures, and the library without books. In 1796 the buildings were found to be very much out of repair, and it was suggested that rather than spend money on them it would be better to sell the lease of the land on which they stood and purchase freehold ground elsewhere on which to erect new premises. Accordingly bids were invited, but at the very meeting at which it was announced that no one of them reached the amount fixed on, the company, by a final act of mismanagement, succeeded in destroying itself. On July 7, 1896, a court, not constituted according to the Act, assembled and transacted business, the result being to determine the corporation's legal existence. Attempts were made to legalize the irregularity by a new Act which also conferred new powers, but they were defeated by the opposition of persons who were in practice without holding the diploma of the company. In the meantime the property in the Old Bailey was sold and a freehold house in Lincoln's-inn-fields—on the site of which stands part of the present Royal College—was purchased. But, as the result of the rejection of its Bill, the company found itself very awkwardly situated, for its business was at a standstill, it could hold no examinations, and many of its members declined to pay their dues. Ultimately a compromise was affected between the court of assistants and the opponents of the Bill, and it was agreed that a new Act should be sought converting the old company into a college. All practitioners in England and Wales were to be subject to its examinations, lectures on anatomy were to be given on a more extended scale, and a library and museum were to be formed. After these terms had been arranged it occurred to some one that a Royal charter was preferable to an Act of Parliament. Accordingly a charter was sought and granted, March 22, 1800.

In this way was constituted the 'Royal College of Surgeons in London,' for the promotion of the study and practice of the art and science of surgery. The number of members in 1800 was about 230, all those who belonged to the old company having the right to become members, though subsequent candidates for membership had to pass a prescribed examination. The court of examiners, whose members held office for life, had also to examine all Army and Navy surgeons, their assistants and mates, and also to inspect their instruments. This constitution remained practically unaltered until 1843, the changes introduced by the supplementary charter of 1822 being merely the substitution of the titles of president and vice-presidents for the old ones of master and governors, and the permission to the college to hold land and rents in mortmain to the annual value of £2000 instead of £1000. It was not, however, completely satisfactory to the general body of members, and it was felt to be somewhat too narrow and oligarchical in character. The governing body, though it had very great authority in the affairs of the college, was small and self-elected, and its members held their position for life; it was composed of surgeons connected with the metropolitan hospitals, and teachers in private and provincial schools did not think they enjoyed all the privileges to which they were fairly entitled. But, though a Parliamentary committee investigated the matter in 1834, nothing was done until 1843, when a new charter established a more democratic form of government. The title was altered to the Royal College of Surgeons of England, and a new class of 'Fellows' was created. The council, which was to be selected from among these, was increased to 24, and the three senior members were to retire every year, though they were eligible for re-election. No Fellow practicing pharmacy or midwifery could be on the council. The constitution of the court of examiners also was altered; its members were to be selected from the general body of Fellows and not exclusively, as formerly, from the council, while the office was to be held not for life but at the pleasure of the council. The charter ordained that between 250 and 300 members should be selected to be Fellows within three months, and it gave the council further powers to appoint a number of other members to be Fellows within the succeeding nine months. The first Fellows, of whom three still survive, were appointed on December 11, 1843, mainly from the surgeons and lecturers at metropolitan and provincial hospitals, while in August, 1844, a further batch of 242 were selected, including a number of representatives of the naval, military and Indian forces. Of these also three survive. All subsequent Fellows were admitted only after examination. Some slight modification of these arrangements was brought about by the charter of 1852, which gave the council power to elect members of 15 years' standing to the Fellowship without examination, provided they had obtained their diplomas of membership before 1843; also to elect two Fellows annually who were members of over 20 years' standing without restriction as to the date of their diplomas. A supplementary charter in 1859 regulated the appointment of examiners in dental surgery, and a fresh one in 1888 increased the annual value of the land that might be held by the college to £20,000. The final modification in the constitution took place this year, when the council was empowered to elect honorary Fellows to a number not exceeding 50. The first of these is the Prince of Wales.

Since 1800 there have been 61 masters or presidents of the college, who have included the most distinguished surgeons of the time. The great majority only held office for a year, but in six cases the term was three years and in one four; Sir William MacCormac, therefore, who is now the president, has exceeded all his predecessors in length of service, for the present centenary year marks his fifth year of office. John Hunter, perhaps the greatest surgeon that has ever lived, was never a member of the college, because he died before its incorporation; yet he may be accounted its greatest ornament. His famous anatomical collections, greatly enlarged, but still arranged on the simple plan he devised, are housed within its walls. At his death Parliament, tardily enough, voted £15,000 for their purchase and entrusted them to the keeping of the old Corporation of Surgeons. When this was dissolved they were handed over to the custody of the present college, which has proved itself worthy of the trust. The museum as Hunter left it contained 13,682 preparations arranged in two divisions—normal structures and abnormal structures; now the number of preparations has been doubled, though the museum is still only an expansion of Hunter's. Over and over again—notably in 1835, 1847, and 1888—the college has added new buildings to accommodate the ever-increasing collections, and in the successive conservators it has appointed—W. Clift, Richard Owen, J. T. Quekett, William Flower and Charles Stewart—it has had the good fortune to find men of the highest scientific attainments who have watched over them with unceasing care. To the first of these, admirers of Hunter are specially indebted, for he was the means of preserving a great part of Hunter's anatomical writings. Originally included with the collections, they were borrowed by Sir E. Home, Hunter's executor, who used them for the manufacture of papers and lectures, to which he attached his own name, and then burnt them so as to remove the evidence of his dishonorable conduct. Clift, however, had made copious extracts from the MSS., and in this way an authentic record of about half their substance has been preserved. The college possesses many memorials of Hunter, including a very fine portrait of him by Sir Joshua Reynolds, his consulting chair, clock, pocket-scales, lancet-case, etc. His 'name and fame' are celebrated by a biennial 'Hunterian Oration,' while numerous Hunterian lectures are delivered in accordance with the conditions on which the collections were entrusted to the college. Another service rendered to the cause of surgical knowledge by the college is to be found in the splendid library it has formed and maintains. This originated in a small grant of £50 made at the very beginning of this century; it now contains 50,000 volumes, including journals and transactions of scientific societies. Finally, reference must be made to the college's important share in examining and licensing physicians and surgeons to practice. This portion of its functions is carried on jointly with the Royal College of Physicians—a return to an arrangement 400 years old—the examinations being mostly held in the examination hall built on the Thames Embankment in 1886, at the joint expense of the two bodies. Here not only is medical knowledge tested but its sum increased, for the hall includes extensive laboratories for original research, where materials are supplied at the expense of the colleges to any of their Fellows or members who obtain permission to work in them. In addition anti-toxic serum is prepared for the hospitals of the Metropolitan Asylums Board and for various general and children's hospitals, the cost of the latter supply being defrayed by a grant from the Goldsmiths' Company.

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*THE DEVELOPMENT OF SURGERY.**

One hundred years have passed since the charter granted by King George III. incorporated the surgeons of England into a Royal College, whereby the art and science of surgery might be the better cultivated and the commonweal of the people of this kingdom benefited.

We meet to-day in order to celebrate the centenary of our incorporation, and the occasion compels us to reflect how far the College has fulfilled its high mission and merited the public consideration and confidence it enjoys, and, as we believe, deserves to enjoy, through unselfish service to the State.

My first and most pleasant duty is to welcome our illustrious guests who have come from many and distant countries to do honor to our College. Amongst them

* Address of welcome on the occasion of the centenary festival of the Royal College of Surgeons of England, delivered by the president, Sir William MacCormac and published in the *British Medical Journal*.

are great surgeons from almost all nations, men who not only hold the highest professional position in their respective countries, but whose public record has made their name familiar to us all, while many of them are dear personal friends.

We have guests, too, our own countrymen, whom we delight to honor, dignitaries of the Church and of the Law, and heads of our ancient seats of learning. Although I cannot enumerate all, I can and do extend to each and every one the most cordial welcome, and would wish to express our grateful appreciation of their presence amongst us.

An occasion like this possesses historic interest. We contrast our present position with that of our predecessors, and rightly congratulate ourselves on our greater knowledge and opportunities, on the facilities we enjoy for investigating the mystery of disease, and for its more effective treatment.

The comparison enables us to realize, as only such a comparison can, the extent of our gains and our increased opportunities for doing good. It leads us at the same time to recognize, as we ought, how large a debt we owe to the workers who have preceded us for so many of those happy results which are now matters of daily accomplishment.

The progress of surgery has been greater during the present century, more especially in the latter portion of it, than in all the preceding centuries combined, and it is of especial interest to us to note that this period of rapid advancement exactly corresponds with the life-history of our College, whose Centenary we are assembled to commemorate.

If we look back—and it is well to look back sometimes—we find in the labors of the old masters of surgery much to enlighten, to widen, and to confirm our views. A knowledge of the history of our art and science tends to make us juster judges both of our own work and that of others.

When we search the history of the development of scientific truth we learn that no new fact or achievement ever stands by itself, no new discovery ever leaps forth in perfect panoply, as Minerva did from the brow of Jove.

Absolute originality does not exist, and a new discovery is largely the product of what has gone before.

We may be confident that each forward step is not ordered by one individual alone, but is also the outcome in a large measure of the labors of others. The history of scientific effort tells us that the past is not something to look back upon with regret—something lost, never to be recalled—but rather as an abiding influence helping us to accomplish yet greater successes.

Again and again we may read in the words of some half-forgotten worthy the outlines of an idea which has shone forth in later days as an acknowledged truth.

We see numerous instances of this in the history of surgery. Some fellow-worker in years long past has discovered a new fact or indicated the path leading to a fresh truth. It is forgotten, and a century later something nearly the same, or mayhap a little better, is discovered afresh. The psychological moment has arrived, and the discoverer reaps the reward, not only of his own labors, but of those of his predecessors as well.

The countless trials and experiments which ended in the general use of ether and chloroform in surgery, that treblyblessed discovery of a sure relief from pain, were guided by the experience of previous trials, half successful, half failures.

The patient labor of our distinguished Fellow, Lord Lister, now President of the Royal Society, has been rewarded by a success to which all the world does homage, and which will crown his head with imperishable laurels. Yet none will be readier than Lord Lister to acknowledge how much the antiseptic methods of wound treatment owe to the researches and discoveries of Pasteur.

If we examine the old books we may find again and again something very near to what is the accepted doctrine of the present time. History, it is said, repeats itself, and so very certainly does surgery. The difficulty of discovering anything new is as great in surgery as in other branches of knowledge. Hippocrates (460 B. C.), the Father of Medicine, classified injuries of the skull in much the same way as that adopted in our modern text-books. He spoke of contusions of the cranium without fracture or depression, of simple fractures, depressed fractures, indented fractures involving the outer table alone, and fractures at a distance from the seat of injury which we now style fractures by *contre-coup*, a classification which leaves but a small margin for improvement.

Many of the surgical instruments found in Pompeii are precisely similar in principle, if not quite equal in workmanship, to those now in use, and Pompeii was destroyed 1800 years ago (A. D. 79).

Heliodorus, who lived at the beginning of the second century A. D., in the time of the Emperor Trajan, was a surgeon of much originality, and appears to have been familiar with some of our modern methods and discoveries. He knew, for instance, of the ligature of arteries, of the radical cure of hernia by extirpation of the sac, and of the excision of a rebellious stricture of the urethra.

Oribasius, who flourished in the middle of the fourth century, A. D., was the friend and physician of the Emperor Julian. He has preserved for us the work of Antyllus, whose treatment of aneurysm by ligature of the vessel above and below the sac, with subsequent incision and evacuation of its contents, has of late years been revived with success, and is still considered by many of our surgeons as the best method of treatment in certain cases. One might cite other examples of old methods consciously or unconsciously revived, but these may perhaps suffice.

The modern specialist finds his prototype in very ancient times, and what we are apt to regard as a recent development is in reality a survival. Herodotus tells us that in Egypt there were as many branches of the profession as there are parts of the human body.

In Europe, until the rise of the Italian Universities, surgery was mainly in the hands of peripatetic charlatans, who cut for stone and operated on hernia. They travelled from town to town, kept their methods secret, and handed them down as family property to their descendants.

The Hippocratic oath restricted the performance of lithotomy to those who had especially devoted their whole energies to the cultivation of this operation, and may partly serve to explain this remarkable survival. Some of these 'cutters' were skilful men, but all were of necessity very ignorant.

A very famous 'cutter,' whose name we do not know, died in Genoa in 1510, and Senerega, the Genoese historian, tells us that his method was to introduce an iron rod along the urethra into the bladder until it touched the stone, which he then extracted through a perineal wound. It has been suggested that this Genoese taught his method to John of Cremona, who is credited with the invention of the grooved staff.

One of the most celebrated 'cutters' was Pierre Franco, who was born in Provence about 1500, A. D. He used a staff and cut on the gripe as well, and employed instruments for the purpose of crushing large stones. He was a man of determination and resource, for he relates a case of a boy in whom having failed to remove a stone by way of the perineum, he successfully performed the suprapubic operation.

The stone was the size of a hen's egg, and the patient subsequently made a good recovery.

Colot was appointed lithotomist to the Hôtel Dieu of Paris in 1556. He had learnt what is known as the 'Marian operation' from an itinerant quack, and he practiced the method with, it is said, much success. The office and the secret descended to his son and to his grandson.

In the great Metropolitan Hospitals—in St. Bartholomew's and St. Thomas's for instance—persons were at one time specially appointed for the purpose of cutting for stone.

John Bamber, who lived during the reigns of William III., Queen Anne, George I. and George II., was the last of the special lithotomists at St. Bartholomew's. He resigned his office in 1730 and his duties were transferred to the surgeons of the hospital, who were specially paid a small stipend each year as lithotomist until 1868. Bamber's portrait by Verelst may be seen at Hatfield House, and Lord Salisbury inherits some portion of his property through an heiress of this line who married a Marquess of Salisbury.

At St. Thomas's Hospital certain of the surgeons were specially appointed to cut for stone, but before the year 1730 there appears to have been a special 'surgeon for the stone,' and the first of these was James Molins, who held a similar office at St. Bartholomew's. There is, indeed, no end to the matters of interest in the history of our art.

The great French surgeon, Guy de Chauliac, who was born about 1300 A. D., studied at the three most famous centers of learning of that time—Bologna for anatomy, Paris for its surgery, and Montpelier for medicine. He travelled much, but finally settled at Avignon, where he became physician in succession to Pope Clement VI., and afterwards to Pope Innocent and Urban. It was in Avignon that he wrote his 'Great Surgery,' and in a special chapter of this work he records opinions which have an application even in the circumstances of our own times. "Formerly," he says, "all medical writers were both physicians and surgeons—that is to say, well educated men; but since then surgery has become a separate branch and fallen into the hands of mechanics."

It is interesting to find from Guy that there were in his day exponents of that modern foolishness called 'Christian Science.' These Guy describes as 'consisting of women and many fools.' They refer the sick of all diseases to the saints, saying:

> Le Seigneur me l'a donné ainsi qu'il Lui a plu. Le Seignenr me l'ostera quand il Lui plaira, le nom dn Seigneur soit benit. Amen.

As a striking instance of my thesis I may take the great French military surgeon, Ambroise Paré. We know his title to fame in substituting the ligature of arteries for the use of the hot iron in the arrest of hæmorrhage. We know also the story of how he forbade the barbarous practice of pouring boiling oil into gunshot wounds, due to the then prevailing belief that these wounds were poisoned, a belief revived with almost every war, even the latest war in South Africa. Paré had been apprenticed to a provincial barber at the age of 9. Soon afterwards he came to Paris, attended lectures at the Faculty of Medicine, and gained admission to the Hôtel Dieu. He lived there as a dresser for three years, 'seeing and knowing a great variety of diseases constantly being brought there.' He was only 19 when he accompanied the King, François I., into Provence to meet the army of Charles V. He was attached to the Courts of four Kings of France, and, although a Huguenot, was spared at the Massacre of St. Bartholomew by the direct intervention of Charles IX.

It is interesting to learn that Dionis, more than one hundred years after Paré's time, was urging at the Hôtel Dieu the adoption of arterial ligature in place of the caustic even then in vogue. Dionis too, although he advised the Marian operation for stone, considered that the risks of the suprapubic method had been overestimated, an opinion revived and insisted on by Sir Henry Thompson in our own time.

We all remember J. L. Petit (1674–1750), who invented the tourniquet known by his name in the early part of the last century, and Anel, who tied the branchial artery for traumatic aneurysm at the bend of the elbow, upon which procedure a claim was based for priority over Hunter, though Hunter's operation is wholly distinct in the principle involved.

Towards the end of the eighteenth century Desault, who nearly lost his life in the Revolution, was the leading French surgeon. He was accused of poisoning the wounds of some of his revolutionary patients in the Hôtel Dieu, and to be accused was in those times almost the same thing as being condemned. Desault, whose fame has been eclipsed by the brilliance of his pupil Bichat, was the first surgeon to teach surgical anatomy after the modern manner, although the great French hospital where he practiced was described at that time as 'the oldest, largest, richest, and worst hospital in Europe.' I need not refer to more recent and greatly honored names—Dupuytren, Velpeau, Nélaton, and many others.

In Germany, even so recently as 100 years ago, surgery was at a low ebb. George Fischer tells us that quacks of all kinds, 'cutters' for stone and hernia, cataract operators, and bonesetters, flourished in the land. The public executioner, whose business it was to fracture bones and dislocate joints on the rack, was supposed thereby to have acquired a knowledge of disorders of these parts, and was consulted freely about them—so much so that Frederick the Great in 1744 published a decree limiting the powers of these men, and while permitting them to treat fractures, wounds and ulcers, forbade them to practice medicine. Hildanus (1560–1634), who lived in Germany at the end of the sixteenth and beginning of the seventeenth century, has been called the Father of German surgery. He was a voluminous writer, a bold operator and his *Opera Omnia* was a work of reference for many years. Heister (1683–1758), a surgeon of much note in the eighteenth century, wrote a *General Surgery*, which enjoyed much repute, and was translated into English. Bilguer (1720–1796), a surgeon-general in the German army was noted for opposing the indiscriminate amputation of limbs then in vogue for gunshot fracture of the extremities, which his predecessor Schmucker had warmly advocated and practiced to an inordinate extent.

Towards the end of the eighteenth century Von Siebold (1736–1807), a famous surgeon, who enjoyed great repute as a clinical teacher and operator, taught anatomy at Würzburg and about the same time Richter (1742–1812) was Professor of Surgery at Göttingen. Richter had travelled much, was familiar with the work done in England and France, and was the best writer and teacher of his day. He was the first to place surgery in Germany on a truly scientific basis. Of those German surgeons whose names still fill our ears with their fame, and whose loss we have recently deplored — Stromeyer, Langenbeck, Billroth, Volkmann, Thiersch, Nussbaum and others—I could only repeat what all of you know as well as or better than I.

The first English surgeon of whom we possess any definite knowledge, and whose writings are still in existence, is John of Arderne. He was born in 1307. He must have been an accurate and close observer, to judge by the graphic description he furnishes of cancer of the rectum. He says:

It breeds within the fundament with great hardness, but with little pain. After a time it is ulcerat, oftentimes all the circumference, and the excrement goeth out continuallie.

He gives a true and telling description of how the condition is to be diagnosed, and of the progress and termination of the disease.

It is noteworthy how many of the older surgeons who attained eminence spent part of their career in the army or navy. William Clowes (1540–1604), who was Surgeon to St. Bartholomew's, had been surgeon in the navy, and wrote *A Proved Practice for all Young Chirurgeons concerning Burnings with Gunpowder and Wounds made with Gunshot,* and he refers to Ambroise Paré in terms of admiration.

The greatest English surgeon of the seventeenth century was Richard Wiseman (1622–1676). He served in the Dutch navy till 1644, and then entered the army of Charles I. Afterwards he spent three or four years in the Spanish navy, and on the Restoration joined the forces of Charles II., by whom he was appointed one of his surgeons. He published many treatises, which exercised a considerable influence on English surgery, but were little known abroad.

William Cheselden (1688–1752) was a surgeon of great renown in England in the early part of the eighteenth century. He was Surgeon and Lecturer at St. Thomas's Hospital. In 1723 he published a treatise on the high operation for stone, but he soon abandoned this for the lateral method, which he so much perfected and improved that the operation remains at the present time much as he left it.

Percivall Pott (1714–1788) was the famous English surgeon of the middle portion of the last century. He was Surgeon to St. Bartholomew's Hospital, and made many and most important contributions to surgery, especially on hernia and on injuries to the head. His name remains attached to many surgical disorders.

Of John Hunter (1728–1793) no detailed mention is required here. His memory and his methods continue a living influence amongst us. He made our surgery a science, and has given to us in our Museum an imperishable memorial of his industry. In it are illustrated those marvellous powers of observation which had never before been equalled, and will never in all probability be surpassed. So long as surgery continues, Hunter's influence must be felt. It is witnessed in the creation of so many distinguished disciples imbued with his principles and able to expound his doctrines. He embodies and represents the glory of our science, our College, and our country.

The historical summary I have attempted would not be complete without some account of the connection existing between the Surgeons and the City of London, which appears to have continued quite without interruption since the middle of the fourteenth century until the foundation of the Surgeons' Company in 1745. There are many entries in the City records of the admission by the Lord Mayor of surgeons and master surgeons to practice in the City of London, and the license thus granted exacted a promise "that they should well and truly serve the people in their cures, and report to the Lord Mayor and Aldermen any surgeon neglecting his patients."

In 1416 the Craft of Barbers practising surgery petitioned the Lord Mayor and Aldermen "to provide a sure remedy against unskilful persons who indiscreetly pretended to be wiser than the Masters of Surgery, and who expose the sick to the greatest danger of death or maim by their presumption." The City took immediate and, as we learn, successful action on this petition.

The City recognized the distinction between barbers and surgeons, for they appointed masters of surgery to control those practising surgery only, and other masters were annually selected to supervise those practising barbery. Early in the fifteenth century the surgeons appear as a distinct body, and in 1423 a College of Physicians and Surgeons, which had been founded chiefly through the influence of John Morstede, a surgeon who accompanied Henry V. to Agincourt, was formally sanctioned by the Lord Mayor, and powers granted to it to examine and control persons practising medicine and surgery in the City of London. The Livery Company of Barber-Surgeons was founded in 1540, and its Hall in Monkswell Street is still standing, and it escaped destruction in the Great Fire of London. The famous picture of Hans Holbein of Henry VIII. delivering the Charter of the Company to the assembled barber-surgeons is still there, where until recently one might see the old theater, where lessons in anatomy were read upon the bodies of executed malefactors.

Thomas Vicary (149(?)-1561), Sergeant-Surgeon to the King, the first Master of this Company, was a wise and honest gentleman. He held a unique position at St. Bartholomew's, and there is in Holbein's picture at the Barber Surgeons' Hall a characteristic portrait of him. Vicary was succeeded by Thomas Gale (1507-1587), who had served with the army of Henry VIII. in France in 1544, and under Philip II. of Spain in 1577. In his *Institutions of Chirurgeons* there is an account of wounds made by gunshot. He opposed the view that they are poisoned, and gives cases to prove that bullets may be left for long in the body without danger.

The Barber-Surgeons appear to have borne their due share in the City pageants. At one given at the Restoration, the Lord Mayor and aldermen appointed that the Company should provide "twelve of the most grave and comlyest personages, appareled with velvet coats, sleeves of the same, and chaynes of gold, to attend the Lord Mayor on horseback."

Mr. Edward Arris, an Alderman and Barber-Surgeon, had a great desire to increase the knowledge of Chirurgery, and to this intent bequeathed to the Company a sum to found lectures, in 1645, on anatomy, on condition that a 'humane' body should once in every year be publicly dissected. The Gale Lecture was founded by John Gale a little later, in 1655, and Havers, well known for his description of the canals in bone, since called Haversian, was appointed the first reader. The Arris and Gale Lectures are still annually delivered in this College, for when the Surgeons finally separated from the Barbers in 1745 they carried nothing with them but the Arris and Gale bequests. The hall, library, and plate remained the property of the Barbers, and the new Company of Surgeons had to make a fresh start in the world.

The Act of Parliament separating the Surgeons from the Barbers became a law in 1745, and a Corporation was established consisting of a master, governors, and Commonalty of the Art and Science of Surgery in London.

John Rauby, one of the prime movers in effecting the change, became the first Master. He was Sergeant-Surgeon to George II., and accompanied that monarch to the battle of Dettingen in 1743. The other active mover was Cheselden, Surgeon to Queen Charlotte's, to Chelsea, and St. Thomas's Hospitals. The first meeting of the new Company was held in the Stationers' Hall, July 1, 1745. Mr. Ranby, as Master, occupied the chair, and Mr. Cheselden and Mr. Sandford were his wardens.

Ten examiners were appointed to conduct the examinations of those seeking the diploma of the newly-constituted Company, and this number is continued in the present Court of Examiners. Part of their duty was to examine surgeons for His Majesty's army and navy, and the examination of surgeons for those services, which had been instituted in the reign of Henry VIII., was continued for a long time by the Court of Examiners until other arrangements were made at a comparatively recent date. It was for this examination, I may note in passing, that Oliver Goldsmith presented himself in order to qualify as a naval surgeon's mate, December 21, 1758. He was unsuccessful, and it was well perhaps, since he could scarcely have written *The Vicar of Wakefield* in the cockpit of a man-of-war. In *Roderick Random* we possess a graphic and probably fairly correct description of one of these examinations, derived, doubtless, from Smollett's personal experience, as he obtained the Company's diploma for a post of surgeon in His Majesty's navy.

The Surgeons established themselves in the Old Bailey, and there they built a theater. In 1753 Percivall Pott and John Hunter were chosen as the first Masters in Anatomy, and no more brilliant choice could have been made. It is recorded that immediately after this election the Court proceeded to discuss how they should dispose of the bodies of three persons who were to be executed a few days afterwards for 'murder,' and then sent to the College theater to be dissected. Amongst these brought in this way was that of Lord Ferrers, executed in 1760 for killing his steward. It was not, however, dissected, but buried in Old St. Pancras Churchyard at the intercession of Lady Huntington.

On July 7, 1796, Henry Cline the elder was elected a member of the Court, but, as it subsequently turned out, the meeting at which this occurred was irregular, and its proceedings illegal, a properly constituted quorum not being present. Although only a technical illegality had taken place, this incident led to the final extinction of the Company of Surgeons, for a bill shortly afterwards introduced into Parliament to legalize the proceeding was thrown out, and the Company was thereupon dissolved. The bill passed the Commons, but was rejected in the Lords, mainly through the influence of Lord Thurlow, who was bitterly opposed to Mr. Gunning, a very distinguished surgeon, and at the time Master. "There is no more science in surgery," Lord Thurlow is reported to have said, "than there is in butchery." "Then," replied Gunning, "I heartily pray your lordship may break your leg and have only a butcher to set it, and my lord will then find out the difference between butchery and surgery."

In 1796 the Surgeons migrated from the Old Bailey to Lincoln's Inn Fields. In that year a new bill they sought for was rejected in the Lords on the ground that the College premises were too far removed from the place of execution, and that it would be indecent and improper to carry the bodies of deceased criminals so long a distance through the streets of London. Finally, the Court in 1797 decided to apply to the Crown, and not to Parliament, for a new charter, and, although opposition was again offered, it proved unsuccessful, and March 22, 1800, the Royal College of Surgeons in London was established by charter of King George III. This charter gave the College its former rights on condition of resigning its municipal privileges. The titles of Master and Governors were retained for a time, but a supplementary charter from King George IV. in 1821 replaced these by those of President and Vice-Presidents. In 1843 another charter, granted by Her Majesty Queen Victoria, changed the title to that of 'Royal College of Surgeons of England,' with a President, two Vice-Presidents, Council, Fellows, and Members, as they exist at the present time. Thus it was that the Royal College of Surgeons of England was created.

During the century of its existence this College has witnessed discoveries which have profoundly changed the character of surgical practice and the scope of surgical aspirations. An immense development has been effected in the operative surgery of every region of the body, and the victories of the surgeon over disease and death are without end.

John Hunter, and many of the older surgeons, regarded operations as somewhat of an opprobrium to surgery, and as a confession of failure. How far otherwise it is now! Intracranial, intrathoracic, and intra-abdominal operations are successfully carried out, many of them by proceedings which had never previously been imagined, even by the boldest amongst us. A great impetus has been given to conservative methods in surgery, and the preservation of life and limb is now attainable in cases innumerable, and of the most different description, where conservation was previously regarded as impossible.

How largely also have physicians and surgeons alike developed and cultivated that highest form of conservation, the conservation of the race in the happiness and vigor which are associated with physical health!

Plastic methods have been perfected in an extraordinary degree. I would only mention as a striking, although common example, the union of the ends of an accidentally divided nerve and the re-establishment of its function.

Although the number and variety of operations have multiplied a hundredfold, the skill and fertility of resource exhibited in their performance have equally increased and the measure of success which has been realized, whilst it rewards and gratifies the surgeon, will appear even to the educated layman as little short of miraculous. In the early part of the century the surgeon knew of but a limited number of operations, and for the most part those only were performed which appeared to be inevitable. He knew by sad experience how generally fatal important operations and cases of severe injury were when treated in hospital wards. His patients were more then decimated by infective diseases—pyæmia, septicæmia, erysipelas, tetanus, and by suppuration, hectic and gangrene. He recognized and could to some extent control these scourges, but of any effective manner of dealing with them he knew nothing. Now we possess an intimate knowledge of the essential causes of many of these diseases, and if we cannot always cure them we can do much to prevent them. Some things have hitherto baffled our efforts. The cause and the cure of cancer are as yet unknown. We possess some crude ideas about the exciting causes of the disease, and attempt with indifferent success to cure it by timely extirpation. Let us hope that the new century will still be young when some surer means of dealing with this terrible and increasing malady is discovered.

A notable feature of our time is the development of the museums which are now attached to most of our public institutions. Those which more immediately concern ourselves illustrate everything within the range of biological science, and foremost amongst them all is our own great collection.

Much more might one say—and much certainly there is to say—but I will only repeat that our welcome to you all is sincere and heartfelt, and most especially so to our foreign colleagues. Our science knows no narrow national boundary. It is the common property of us all. We desire to sympathize with our fellow-workers abroad, and to appreciate their work, as we trust and believe that they appreciate ours.

In this address I have ventured to urge that we are much beholden to those who have gone before. In but a few years all who are now present will also belong to the past. Let us hope that, as we have not altogether forgotten those who preceded us, we too may be remembered a little by those who are to follow.

On great occasions like the present, the older seats of learning and other public institutions had power to grant honorary distinctions. Formerly we possessed no such faculty, but by the act of Her Gracious Majesty we, too, have recently obtained permission to grant a certain number of Honorary Fellowships of this College. The Fellowship is the greatest distinction it is in our power to bestow, and we regard it as the highest purely surgical qualification obtainable in this country. It is, therefore, a great privilege and pleasure for me to present, on behalf of this College, this high honor to those distinguished men who are about to receive it.

I am sure also all present will be gratified to learn that His Royal Highness the Prince of Wales has graciously consented to become the first of our Honorary Fellows. His Royal Highness has always shown his interest in the College, and has evinced a special care for the success of its Centenary. It is quite fitting, therefore, that his Royal Highness, who is the patron of so many learned and scientific societies, should add the lustre of his name to the Royal College of Surgeons of England.

WILLIAM MACCORMAC.

CHEMISTRY AT THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION.

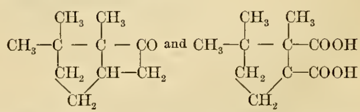
As has been the practice for a number of years Section C met throughout the New York meeting in joint session with the American Chemical Society. The sessions took place in Havemeyer Hall, Columbia University, with the exception of those on the second day of the meeting, which were held at the Chemists' Club of New York City by special invitation of its officers.

At the opening session of the Section, after the election of the usual officers, a report of the Committee on Indexing Chemical Literature was presented, in which the completion of some new important indexes was announced. This report has been already published in this JOURNAL. A resolution relating to the establishment of a National Standards Bureau, submitted by the President of the American Chemical Society, was endorsed by the Section and referred to the Council of the Association.

The address of the Vice-President, Dr. Jas. Lewis Howe, on the 'Eighth Group of the Periodic System and some of its Problems,' has been already published in full in SCIENCE (see the July 6th number).

A large number of valuable scientific papers were presented. As is always the case, many of them, though important, were of a specialized or technical character. Only a few of those having a more general interest can be referred to here.

First may be mentioned the address of Dr. W. A. Noyes on the 'Structure and Configuration of Camphor and its Derivatives,' consisting of a historical review of the previous work bearing on the subject and a brief account of his own remarkable and difficult syntheses of compounds closely related to camphor, and of the establishment of their identity with products obtained directly from it. By his investigations, the correctness of the formulæ for camphor and camphoric acid suggested by Bouveault and Perkin respectively, viz :



seems to have been placed beyond a reasonable doubt. Two other points connected with the investigation deserve special mention ; first, the isolation of an optically active acid containing *no* asymmetrical carbon atom, its activity being due to the asymmetrical structure of a ring containing a double-union ; and, second, the method used for establishing the identity of two compounds from different sources consisting in determining whether any change of melting point occurs on mixing the two substances—a far more reliable criterion than mere identity of melting point. Though this method has been used before it is not commonly employed.

Reference should also be made to the beautiful investigation of Dr. A. S. Wheeler on the reduction-products of dehydromucic acid, who has prepared the various stereoisomers of the hydrogenated acids; also to the extended researches of Professor C. F. Mabery and his co-workers on the composition and characteristics of the products obtained from petroleums of different origins.

An interesting account was given by Mr. C. L. Reese of the recently developed process of manufacture of sulphuric acid by the direct union of sulphur dioxide and oxygen through contact with finely divided platinum. The preparation and regeneration of the contact-mass was minutely described, as well as other details of the manufacture, which is at present being carried on industrially on a fairly large scale. Samples of the contact-mass were exhibited, and a striking lecture experiment illustrating the formation of the trioxide by means of it was shown by the speaker.

Professor W. O. Atwater gave an interesting description of the results obtained with his respiration calorimeter on the income and outgo of matter and energy in the bodies of men under experiment, proving that the Law of the Conservation of Energy is applicable to the human organism.

Much discussion was excited by the papers read by Professor Louis Kahlenberg who presented a series of experimental results of various kinds, with which, according to his interpretation, the Theory of Electrolytic Dissociation is inconsistent. The validity of his arguments was, however, called in question, and the great value and wide scope of that theory strongly emphasized by some other members of the section.

The following is a complete list of the titles of the articles presented:

Some Results of Experiments with the Respiration Calorimeter: By W. O. Atwater, Middletown, Conn.

Experiments with some Substituted Benzoic Acids and their Nitriles: By Marston Taylor Bogert and August Henry Gotthelf.

The Direct Synthesis of Ketodihydroquinazolins from Orthoamido acids: By Marston Taylor Bogert and August Henry Gotthelf.

The Direct Preparation of Imides of the Bibasic Acids from the Corresponding Nitriles: By Marston Taylor Bogert.

On Certain Reactions in Liquid Ammonia: By Edward C. Franklin and Orin F. Stafford, Lawrence, Kan.

Notes on the Constituents of Ligament and Tendon: By William J. Gies, New York City.

The Adulteration and Methods of Analysis of the Arsenical Insecticides: By J. K. Haywood, Washington, D. C.

The Composition and Analysis of London Purple: By J. K. Haywood, Washington, D. C.

On some Derivatives of Phenyl Ether: By H. W. Hillyer, Madison, Wis.

A Plea for the Use of the Thermostat for the Laboratory Room: By Arthur John Hopkins, Amherst, Mass.

Crystallization of Copper Sulphate for Quantitative Analysis: By Arthur John Hopkins, Amherst, Mass.

Apparatus for dispensing with the Assistant during Calibration by Telescope: By Arthur John Hopkins, Amherst, Mass.

The Theory of Electrolytic Dissociation as viewed in the Light of Facts recently ascertained: By Louis Kahlenberg, Madison, Wis.

The Toxic Action of Solutions of Acid Sodium Salts on Lupinus Albus: By Louis Kahlenberg and Rollan M. Austin, Madison, Wis.

The Toxic Action of Solutions of the Leech and the Vinegar Eel: By Louis Kahlenberg and John B. Emerson, Madison, Wis.

The Toxic Action of Electrolytes upon Fishes: By Louis Kahlenberg and Hugo F. Mehl, Madison, Wis.

Differences of Potential between Metals and Non-aqueous Solutions of their Salts: By Louis Kahlenberg, Madison, Wis.

I. *The Chlorine Derivatives of the Hydrocarbons in California Petroleum.*

II. *Determination of the formulas of the Hydrocarbons and Chlorine Derivatives of Pennsylvania, California, Japanese, and Canadian Petroleum by Molecular Refraction:* By C. F. MABERY and O. J. SIEPLEIN Cleveland, Ohio.

I. *Composition of the Hydrocarbons in Pennsylvania Petroleum, Liquids and Solids, above 216°.*

II. *Composition of the Hydrocarbons in California Petroleum, Liquids.*

III. *Composition of the Nitrogen Compounds in California Petroleum:* By CHARLES F. MABERY, Cleveland, Ohio.

Composition of the Hydrocarbons in Japanese Petroleum: By C. F. MABERY and S. TAKANO, Cleveland, Ohio.

The Sulphur Compounds and their Oxidation Products and Unsaturated Hydrocarbons in Canadian Petroleum: By C. F. MABERY and W. O. QUAYLE, Cleveland, Ohio.

The Structure and Configuration of Camphor and its Derivatives: By W. A. NOYES, Terre Haute, Ind.

Some Compounds of Methyl Sulphide with Metallic Halides: By FRANCIS C. PHILLIPS, Allegheny, Pa.

The Reaction of Potassium Hydroxide on Chloroform: By A. P. SAUNDERS, Clinton, N. Y.

Application of Chemical Methods to the testing of Wheat Flour: By HARRY SNYDER, St. Anthony Park, Minnesota.

A New Volumetric Method for the Determination of Silver: By LAUNCELOT W. ANDREWS, Iowa City, Iowa. (The paper will be published in the *Amercian Chemical Journal.*)

Method for the Analysis of Glass: By E. C. UHLIG.

Notes on the Ferrocyanides of Lead and Cadmium: By EDMUND H. MILLER, and HENRY FISHER.

Notes on the Determination of the Spontaneous Combustion of Oils when Mixed with Wool Waste: By LEONARD P. KINNICUTT and HERMAN W. HAYNES, Worcester, Mass.

Investigation as to the Nature of Corn Oils. Second paper: *Determination of the Constitution:* By HERMAN T. VULTE and HARRIETT WINFIELD GIBSON.

Notes on the Determination of Phosphorus as Phosphomolybdic Anhydride: By H. C. SHERMAN and H. S. J. HYDE.

New Methods for the Separation of some Constituents of Ossein: By WM. J. GIES.

Texas Petroleum: By H. W. HARPER.

The Hydrogen Reduction Products of Dehydromucic Acid: By A. S. WHEELER, Cambridge, Mass.

ARTHUR A. NOYES,
Secretary, Section C.

ANTHROPOLOGY AT THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION.

THE anthropologists met for organization in Schermerhorn Hall, Columbia University, on Monday, June 25th, at twelve o'clock, Vice-President Amos W. Butler, of Indianapolis, presided at this and subsequent sessions excepting that of Tuesday morning. Dr. J. Walter Fewkes, Miss Alice C. Fletcher and Mr. M. H. Saville were elected members of the Sectional Committee; Professor Joseph Jastrow—whose resignation later caused a vacancy that was filled by the election of Mr. Stansbury Hagar—was elected a member of the General Committee, and Mr. George G. McCurdy was elected press secretary. As Vice-President Butler's address is to be delivered at the meeting of 1901, the Section adjourned on Monday afternoon to allow the members an opportunity to hear the Vice-Presidential addresses that were given at three and four o'clock before other Sections.

Arrangements having been made for a meeting with the American Psychological Association, the morning session of Tuesday, June 26th, was presided over by Professor Joseph Jastrow, president of that Association, and four papers upon psychologic subjects were read. The undesirability of meetings of Section H being held in conjunction with those of the Psychological Association has been ably shown by the secretary of the Columbus Meeting in his report in this JOURNAL. In the opinion of the present writer and that of the majority of the Sectional Committee it is eminently desirable that close affiliation continue between the Anthropologists and the Psychologists; but the presentation of papers whose subject matter ranges from experimental psychology to metaphysics before the anthropologic Section has not proved satisfactory. If the psychologists are to continue in the Association they should have a separate section. In college curricula psychology is much more widely recognized than is anthropology, there would seem to be no logical grounds for making psychology an outrider for Section H in the American Association for the Advancement of Science.

Henry Davies read a paper upon 'Methods of Æsthetics'; Edward Thorndike one upon 'Practice.' J. McK. Cattell illustrated a new method of demonstrating physiological processes that are dependent upon mental conditions. The stereopticon was used to show upon the screen the tracings made upon a revolving disk of smoked glass. Thus the quantitative character of breathing, muscular fatigue, etc., were shown to the audience as they took place. Charles H. Judd reported upon his 'Studies in Vocal Expression.' Records upon smoked paper were shown that had been made by a diaphragm and enlarging lever. Measurements of two hundred and fifty metrical feet, English hexameter, demonstrated that the theory that English metrical feet are all of uniform temporal quantity must be rejected.

The afternoon session opened with a paper by Dr. Thomas Wilson upon 'Criminology.' He traced the historical development of his subject from the time of John Howard down to the present. The speaker expressed his dissatisfaction with the manner in which crime had been treated in America. It has been clearly defined and the criminal punished, but due heed has not been given to causes and methods of prevention. Dr. Wilson argued that Lombroso's theories, associating certain types of crime with definite physical characters, were based upon unreliable statistics. It would be more correct to say that crime determines the physical structure than *vice versa*, that environment is more responsible for crime than hereditary character. In conclusion, accurate and extensive statistics are desired. Methods for securing these are being developed, such, for example, as described in the succeeding paper by Vice-President Butler.

In an exposition of 'A Method of Registration for certain Anthropologic Data,' Mr. Butler outlined the developments of a method of obtaining and recording facts regarding defectives, delinquents, and dependents. The system was developed and is in use in the office of the Indiana Board of State Charities. Samples of the blanks and records were shown.

Professor Otis T. Mason's paper upon 'The Trap: a Study in Aboriginal Psychology' contained a classification of the various forms of instruments employed by the aboriginal Americans to secure animals. The mental capacities of the inhabitants of the several culture areas, as determined by their skill in devising, killing or capturing apparatus, were compared.

W. H. Holmes gave a brief exposition of 'The Ancient Aztec Obsidian Mines of the State of Hidalgo, Mexico.' The use of obsidian for the manufacture of implements was very common throughout Mexico. The only mine of importance so far discovered is that of Hidalgo, a hundred miles northeast of the City of Mexico. The work on this site has been very extensive and the pittings cover at least one square mile. The quarries were worked mainly for the securing of cores or nuclei for making flake knives, thousands of the rejected cores being found in the quarries. That the mines were worked by Aztecs is shown by the fact that typical Aztec pottery is distributed through the debris of the work-shop.

Geo. G. MacCurdy followed with a paper upon 'The Obsidian Razor of the Aztecs.' The differences between the fracture of flint and obsidian were described and the excellence of obsidian as a material for the manufacture of knives and razors was demonstrated by lantern views.

A paper by Dr. Washington Matthews gave a brief account of the progress made by the Navahos in the art of weaving blankets and then called attention to a new style of weaving that is described by his title—' A two-faced Navaho Blanket.' The web has totally different figures on the two sides. These blankets are not numerous and the art of weaving them is not encouraged by the traders to whom the Navahos sell the products of their looms.

Harlan I. Smith reported upon the progress made by the party of archæologists under his direction working in the interests of the Jesup North Pacific Expedition in 1899. Shell heaps, cairns and graves were examined in Washington and British Columbia. The results of these investigations were described and in part illustrated by lantern views.

A second paper by Mr. Smith described the cairns of southeastern Vancouver Island and the adjacent coasts. These cairns consist of rude stone vaults containing flexed skeletons that have been buried without the implements and utensils that are usually deposited with the dead by the aborigines.

Alice C. Fletcher presented a valuable paper entitled ' Giving Thanks; a Pawnee Ceremony.' The ceremony was witnessed by the speaker, May 20, 1900, in a Pawnee camp in Oklahoma Territory. The rite is described and three points indicated upon which it throws light. (1) The native belief as to the causes which secure efficacy to the medicine administered. (2) The intermediary position of the doctor. (3) The meaning and purpose of the fees given him for his services.

The paper by Francis La Flesche described the proceedings of ' The Shell Society among the Omaha,' as witnessed by the author when a boy and as he understood it from the accounts of the secret ritual during the past year by the older members of the Society.

Mrs. Zelia Nuttall exhibited a cast of Kollmann's reconstruction of the head of a woman of the Swiss Lake-Dweller type, and commented upon the difficulties in the way of a successful reproduction.

The program for Wednesday closed with the paper by Roland Steiner upon ' Braziel Robinson; possessed of two spirits.' This account of a negro superstition is but one of several score of interesting folk-lore tales that Dr. Steiner has collected.

W J McGee opened the morning session of Thursday with an address upon ' The Responsivity of Mind,' a discussion of cultural coincidences in the Old World and the New that lend support to the doctrine of mental unity among mankind.

' The Law of Conjugal Conation ' was explained by the same speaker, who emphasized the importance of the rôle played by personal affection in human development.

Charles E. Slocum exemplified the thesis that ' A Civilized Heredity is stronger than a Savage Environment,' in the story of Frances Slocum abducted by the Delaware Indians, at the age of five years, and remaining with them until her death, sixty-eight years afterward. Her character furnishes strong evidence in favor of the importance of heredity. "She was plain and practical in outward display, while in the midst of those inclined to gaudiness; she was free from enervating habits, though in the midst of indulgences; industrious, where idleness abounded; cleanly, while surrounded by squalor; accumulative, among a wasteful race; considerative and sound of judgment, in the midst of impulsiveness; and patient in doing her duty according to the best of her knowledge." Thus it was shown that her English ancestry was a stronger factor in molding her character than her savage environment.

' The Sedna Cycle, a Study in Myth Evolution,' was presented by H. Newell Wardle.

The aim of this study was to show the real character of the ideas that the Inuit fancy has woven into the song and story of the Sedna group, to trace their changes from tribe to tribe and to learn the reasons for their variation.

The author comes to the conclusion that subsequent to the rise of the proto-Sedna myth, the crossing of the arctic circle brought the diurnal and annual myths into close relation when the recognition of their affinity resulted in a mutual borrowing.

'The Peruvian Star-chart of Sulcamayhua' was discussed by Stansbury Hagur. About thirty years ago a group of manuscripts relating to early Peruvian culture was discovered in the National Library of Madrid. Among them was an account of the antiquities of Peru, written about 1610 by Salcamayhua, and containing a stellar chart which is a veritable key to the symbolical astronomy of the Inca empire.

The two oblique lines at the top represent the sky. Immediately below appear the five stars of the Southern Cross, and below them the figure of a large egg, symbol of the Universal Spirit. On the left is seen the sun as a man above the morning star, and on the right the moon as a woman with the evening star beneath. On the lower part of the chart are the twelve signs of the zodiac.

W. K. Moorehead gave a brief review of the facts that he had recently ascertained regarding 'The Bird Stone Ceremonial.' A more detailed study of this class of ornaments was urged and their peculiarities indicated by an exhibition of original specimens.

'A Navaho Initiation' was described by Washington Matthews. The Navahos rarely punish their children, but they frighten them with the masked characters of the Night Chant, the principal one of which is the Yayhichy or maternal grandfather of the gods. When children are naughty they tell them that this person will punish them. At their initiation "they are subjected to a symbolic punishment, after which the supposed gods unmask and show themselves to be ordinary individuals masquerading." The children are then permitted to look through the eyeholes and learn the nature of the mask. They acquire certain privileges at this time.

The sessions on Friday, June 29th, were held in the lecture room of the Department of Anthropology of the American Museum of Natural History. M. H. Saville read a paper upon the ancient tombs at Mitla, Mexico.

Mrs. Zelia Nuttall explained the 'meaning of the ancient Mexican calendar stone,' showing that a single primitive, cosmical scheme and plan of government prevailed throughout ancient America. The author has furthermore ascertained that the American scheme is identical with that carried out in remotest antiquity by the peoples of the old world. The great calendar stone was shown to be the most elaborate representation known of the cosmical plan, which formed the common basis of the ancient civilizations of the old and new worlds.

F. W. Putnam exhibited a 'new type of pottery from Texas.'

The remainder of the day was devoted to the examination of the collections of the museum, which were explained by the curator and his assistants.

On Thursday morning, June 28th, the Council voted to change the name of the 'Committee upon the Study of the White Race in America' to the 'Anthropometric Committee.' This committee provided means for taking measurements upon members of the Association during the meeting.

The 'Committee upon the Introduction of Anthropologic Teaching' was made a standing committee of the Association by the Council. Section H was given authority to hold a winter meeting at such time and place as the Sectional Committee should decide.

FRANK RUSSELL,
Secretary.

HARVARD UNIVERSITY.

SCIENTIFIC BOOKS.

Etude sur la grêle. Défense des recoltes par le tir du canon. By V. VERMOREL. Librairie du Progrès Agricole et Viticole ; Villefranche. July, 1900.

In this pamphlet of 77 pages the well-known viticultural expert and director of the station at Villefranche gives an account of the latest (up to July 1st) phase of the subject of Wetterschiessen—the protection of crops from hail by means of the vertical firing of specially constructed cannon at the threatening clouds. Chapter 1 gives a *résumé* of the various theories of hail-formation, affording striking proof of the uncertainty still existing in this regard, and especially as to the part played by atmospheric electricity in the most damaging hailstorms, viz, those of summer. There follows a brief discussion of the possible explanations of the action of the vertical projection of the annular whirl, which seems to be essential to the production of the effect, and *e. g.*, tears a paper target placed 100 meters from the gun, and according to trigonometric measurements may reach a height of over two kilometers. The claim made, and sustained by an overwhelming number of observations, is that the commotion caused by these whirls in the hail-clouds, if produced in time, will cause rain to fall in place of hail.

Chapter 2 gives abstracts of the reports made to the congress of Italian hail-protection syndicates held at Casale Monteferrato in November, 1899, which was attended by three delegates from France, the author among the number. The reports are from the provinces of Vicenza, Treviso, Verona, Padua, Udine, Pavia, Bergamo, Alexandria and Novara. From all of these regions the reports are very encouraging, in part enthusiastic. The Bergamo reporter sums up by saying that "those who have done the shooting are desirous of continuing it ; those outside the defended area regret not having done it. The results obtained this (last) season could not be more encouraging, and will enable us to complete the means of defense." This appears to be substantially the consensus of opinion of those attending the congress.

Chapter 3 gives the details of the construction and handling of the cannon, which does not differ materially from the original prescriptions of Stiger, except in making the gun breech-loading.

Chapter 4 gives details of the desirable organization of the shooting stations, as now established in the Beaujolais, Rhone Valley. Isolated guns are of little value unless placed on high points. Each gun can defend 25 hectares (62 acres); rapid and continuous firing is especially important at the first approach of the cloud. A code of signals is provided to insure concerted and prompt action. The government supplies powder for the purpose at reduced rates. The expense of establishing a station is placed at 11 francs ($2.15) per hectare, or a little less than $1 per acre ; current annual expense, about 65 cents per acre, estimating that 500 shots may have to be fired.

Among the striking points noted is that from 2000 stations last year, *fifteen thousand* are in operation in Italy this year. Moreover, the insurance companies heve reduced the premiums 33 per cent. for the areas provided with shooting stations.

Is it not about time that some experiments in the same line were set on foot in our thunderstorm-ridden Middle West? If, as some allege, this is merely a passing popular delusion, it is a remarkably persistent one, backed by very heavy pecuniary investments, and not definitely assailable on scientific grounds.

E. W. HILGARD.

A Brief Guide to the Commoner Butterflies of the Northern United States and Canada. By SAMUEL HUBBARD SCUDDER. New York, Henry Holt & Co. 1899. Pp. xi + 210, 22 plates of wood-cuts, 10 cuts in text.

This book is a reprint of the first edition of the work, published by the same house in 1893, and so far as the reviewer is able to ascertain, is not different in any respect from the first edition, save in the addition of the plates, which were taken for the most part from the plates, contained in Mr. Scudder's monumental work upon the Butterflies of New England.

The book is a very convenient manual for use on the part of beginners residing in New England and the Middle States, the species treated being for the most part the butterflies commonly found in these sections of our country. The instructions for collecting, rearing, and studying butterflies are brief, but most excellent.

The interest in the study of natural science is rapidly increasing, 'nature study,' so-called, having found a prominent place in the work of our common schools. Such brief compends as these, which are strictly accurate, and adapted to the wants of the ordinary teacher and pupil, are therefore certain to receive favorable attention, and more and more to attract a widening circle of readers and purchasers. The book has already proved its worth, as have all the writings of its learned author, and the issue of this second edition should be cause for congratulation alike to author and publishers.

W. J. Holland.

SCIENTIFIC JOURNALS AND ARTICLES.

The Popular Science Monthly for August has for its frontispiece a portrait of Professor R. S. Woodward, President of the American Association for the Advancement of Science, while the first article, 'Rhythms and Geologic Time,' by G. K. Gilbert, is the address of the recent President of the Association. R. W. Wood describes 'The Photography of Sound Waves,' Havelock Ellis discusses 'The Psychology of Red,' Simon Newcomb continues his 'Chapters on the Stars,' and James Collier has the third of his papers on 'Colonies and the Mother Country.' Carl H. Eigenmann discusses the 'Causes of Degeneration in Blind Fishes,' stating that all indications point to use and disuse as the effective agents in moulding the eye. William Baxter, Jr., treats of 'The Evolution and Present Status of the Automobile,' and A. W. Greely summarizes the 'Scientific Results of the Norwegian Polar Expedition.' The Departments of Discussion and Correspondence, Scientific Literature, and The Progress of Science are well filled.

Bird Lore for August opens with the first instalment of a paper on 'The Orientation of Birds,' by Capt. Gabriel Reynaud, of the French Army, who takes the ground that there is a 'sense of direction.' William Brewster contributes 'A Study of a Lincoln's Sparrow,' and Harry S. Warren treats of 'The Birds that Pass in the Night.' There are numerous notes and book notices. The Editor discusses the proposed agreement with the Millinery Merchants' Protective Association regarding the use of American birds, and Mabel Osgood Wright treats of the same subject under the reports of Audubon Societies, taking the ground that no compromise can be made, that unless all birds can be protected none should be. It is to be feared that we are, on a smaller scale, to have a repetition of the differences existing between prohibitionists and advocates of high license on the liquor question.

Herr Barth, Leipzig, has begun the publication of a journal entitled *Zeitschrift für Tuberkulose und Heilstättwesen* edited by Professors Gerhardt Frankel and von Leiden. The first number contains a series of important articles, including contributions in French and English.

Dr. J. C. Arthur, Purdue University, has retired, owing to ill health and pressure of work, from the position of responsible editor of the *Botanical Gazette* which he has filled for the past fourteen years. The journal is now edited by Professor John M. Coulter and Professor C. R. Barnes, with other members of the botanical staff of the University of Chicago. Professor Arthur becomes an associate editor, the other American associate editors being Professor Robert A. Harper, University of Wisconsin; Professor Volney M. Spalding, University of Michigan; Professor Roland Thaxter, Harvard University, and Professor William Trelease, Missouri Botanical Garden.

DISCUSSION AND CORRESPONDENCE.

INTERNATIONAL CATALOGUE OF SCIENTIFIC LITERATURE.

To the Editor of Science: I am authorized by the Secretary to bring to your attention the fact that, after a number of discussions by scientific representatives of nearly all nations, it was decided at an International Conference held in London in June, 1900, to publish, beginning with the year 1901, an International Catalogue of Scientific Literature, which is to be issued only in the form of annual volumes at first. The Catalogue is to include both an author and a subject index. It will comprise the following subjects: Mathematics, Mechanics, Physics, Chemistry, Astronomy, Meteorology (including Terrestrial Magnetism), Mineralogy (including Petrology and Crystallography), Geology, Geography (Mathematical and Physical), Paleontology, General Biology, Botany, Zoology, Human Anatomy, Physical Anthropology, Physiology (including Experimental Psychology, Pharmacology and Experimental Pathology), and Bacteriology; in all 17 subjects. At least one volume will be given to each subject, and it is proposed that not all the volumes shall be issued at once, but in four groups, as soon as possible after the first of January, April, July and October respectively. The subscription price for a complete set of the whole Catalogue in 17 volumes is £17, say $85.00.

The Smithsonian Institution has provisionally undertaken to represent the interests of the Catalogue in the United States, and will receive promises of subscriptions. The publication of the Catalogue cannot be undertaken unless subscriptions for about 300 complete sets a year (equivalent to about £5000) *for five years* be guaranteed beforehand. Germany has guaranteed subscriptions to the extent of 45 complete sets (or £750), and the Royal Society of London has guaranteed the same for Great Britain and Ireland; it is hoped that at least an equal number of subscriptions will be guaranteed in the United States. It is most important that the necessary guarantee for subscriptions should be completed before September 30th, at the very latest, hence it is desirable that promises of subscriptions in the United States should be sent in before September 15th.

The prices of individual volumes will be eventually fixed by the Central Bureau, and will vary, but so that the aggregate of the individual volumes will amount to £17. In England the Royal Society is making arrangements by which, in the case of special institutions desiring only parts of the whole Catalogue, the subscription for a complete set may be divided among them. It is learned that subscriptions to about 90 sets are yet required, and of these, besides the 45 sets guaranteed by the Royal Society, a Fellow of that Society has guaranteed 45 additional sets on condition that the United States would subscribe for a like amount. It thus appears that the success of this undertaking now depends upon the subscriptions received in this country.

Very respectfully yours,

Richard Rathbun,
Assistant Secretary.

Smithsonian Institution, August 6, 1900.

THE BUFFALO EXPOSITION.

To the Editor of Science: I should be glad if you would let me call the attention of your readers to the Department of Ethnology and Archæology of the Pan American Exposition.

The exposition has provided a circular building 128 feet in diameter, and has also arranged for a 'Six Nation' Indian exhibit on the grounds, with a representation of the typic 'Long House' of the Iroquois and an attendance of some 60 Indians, who will be engaged in such industries as basket-making, woodwork, etc. As these Indians are pagans, and have preserved to a great degree their ancient customs, they will celebrate in appropriate seasons their various thanksgiving festivals, dances and other rites.

Every precaution will be taken to protect exhibits against fire or theft and loss in packing and unpacking. It is expected, therefore, that a large amount of valuable archæologic material will be placed at the disposal of this department by museums and individual collectors. In fact, it is not too early to assure the public that the promises of such institutions as the American Museum of Natural History, The Peabody Museum, University of Pennsylvania, University of Chicago and the Buffalo Society of Natural Sciences as well as the friendly co-operation of the Ministers of the South American Republics, guarantee the success of this department. At the same time, there is always room for more, and as the aim of this Department is not so much to get together a large miscellaneous collection of relics as to afford a means of popular instruction in American archæology, it is desired that students from all parts of the country shall send exhibits or memoranda descriptive of results obtained in their special fields of labor. For example, one exhibit will show the animals domesticated by the Aborigines of the Western Continent, and will explain why the lack of large useful animals capable of domestication hampered the development of civilization in the New World.

Through the co-operation of the Department of Agriculture and Horticulture, exhibits will be made of the plants cultivated in both North and South America before the discovery.

Often the placard is of as great value as the specimen, and one of the features of the exhibit will be cases describing in brief various types of stone age implements and the methods of manufacturing them. Any student of American archæology who has elaborated some special phase of the subject and wishes to place his work before the public may send on manuscript, and placards will be made from it, with due credit to the investigator.

A. L. Benedict.

NOTES ON INORGANIC CHEMISTRY.

The first installment of the promised revision of the atomic weight of iron by Professor Theodore W. Richards has appeared in the *Zeitschrift für anorganische Chemie*, the work being done in conjunction with Dr. Gregory P. Baxter. The method used is the reduction of ferric oxid by hydrogen, the temperature used being 900°. The oxid was formed in two different ways: first, by precipitation from ferric nitrate of the hydroxid, which was dehydrated at 900°; second, by direct heating of the nitrate at 900°. The first method gave in two experiments the figure 55.90. The series by the second method —five experiments — gave 55.883. This is slightly lower than the generally accepted figure, 56.0, and the paper discusses briefly possible sources of error in earlier determinations. Further work on other compounds is to be carried out.

A few years ago Krüger described a red solution formed by leading chlorin into an alkaline solution of copper, which was supposed to contain a salt of a cupric acid. This work has been repeated by F. Mawrow and described in the *Zeitschrift für anorganische Chemie.* So far from getting the above results, a brown powder resulted, having the approximate composition of 6 CuO, H_2O. The proportion of active oxygen was never more than a small fraction of a per cent., whether the experiment was carried out at a boiling temperature, or cooled by ice.

In the *Annales de chimie et de physique*, G. Baudran describes a very considerable series of 'tartar emetics,' double tartrates of metals and alkalies, corresponding to the ordinary tartar emetic, potassium antimonyl tartrate. They are generally formed by dissolving the hydroxid of the metal in tartaric acid, and treating the product with an alkaline tartrate. The emetics of manganese, bismuth, iron, aluminum, and chromium were formed, as well as borotartaric acid and potassium borotartrate.

As far back as 1829 a salt was discovered by Zeise, formed by the action of alcohol upon platinum chlorid, which he called acechlorplatin and to which he gave the formula (in modern nomenclature) KCl, C_2H_4, $PtCl_2$, H_2O. For a few years this compound, combustible chlorid of platinum as it was sometimes called, excited much attention, and Liebig and others attacked unsuccessfully the composition proposed by Zeise; but standing alone as it did, with no compounds of analogous character, for more than half a century few workers have noticed it, though Birnbaum in 1868 proved the correctness of Zeise's proposed composition. In 1844 Reiset formed a compound by the action of ammonium nitrate on the salt of Magnus which he considered to be platosammin chlorid, $Pt(NH_3)_2Cl_2$, but which Cossa proved fifty years later was salt of a platosemiammin chlorid, $PtNH_3Cl_2$. Now in the last number of the *Zeitschrift für anorganischen Chemie*, S. M. Jörgensen, who has so enlarged our knowledge of the platinum and other metallic bases, shows the complete analogy between these salts of Zeise and of Cossa, the latter giving a double alkali salt of formula KCl, NH_3, $PtCl_2$,H_2O, which corresponds exactly to a salt of Zeise in which ethylene is replaced by ammonia. A number of other compounds of these salts were formed and in every case were analogous, in crystallographical character as well as in chemical composition. It is interesting to see two compounds, each of which had appeared for half a century or more to be unique, thus shown to be of the same type, and it is by no means impossible that other salts of this type may yet be discovered.

IN 1886 Linnemann claimed to have discovered in orthite a new metal which he named *austrium*, but this work was never confirmed. Richard Přibram has recently repeated the work of Linnemann and concludes, as had Lecoq de Boisbaudran, that austrium is identical with gallium. But he also concludes from a very thorough spectroscopic examination of the same orthite, that there is a new element present which has not yet been isolated, which is entirely distinct from Linnemann's austrium, and to which Přibram proposes to give the earlier name austrium.

J. L. H.

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*THE INTERNATIONAL ASSOCIATION OF ACADEMIES.**

THE Academy will recall the fact that at the conclusion of the mission entrusted to M. Moissan and myself, consent was given to the 'Projet de Statuts pour l'Association internationale des Académies,' drawn up by the delegates of the nine Academies represented at the Conference held at Wiesbaden early in October last, at the invitation of the Academy of Berlin.

The international Association is now constituted; and it includes the eighteen following Academies:

1. Academy of Sciences..............Amsterdam.
2. Prussian Academy of Sciences..Berlin.
3. Academy of Sciences, Literature and the Fine Arts........Brussels.
4. Hungarian Academy of Science................................Budapest.
5. Academy of Sciences..............Christiania.
6. Society of Sciences................Göttingen.
7. Academy of Sciences of Denmark................................Copenhagen.
8. Academy of Sciences of Saxony.Leipzig.
9. Royal Society.......................London.
10. Academy of Sciences of Bavaria ....Munich.
11. Academy of Inscriptions and Literature..........................Paris.
12. Academy of Sciences..............Paris.
13. Academy of Moral and Political Sciences.......................Paris.
14. Academy of Sciences..............St. Petersburg.
15. Academy dei Lincei..............Rome.
16. Sweedish Academy of Sciences Stockholm.
17. Academy of Sciences..............Washington.
18. Academy of Sciences..............Vienna.

Amongst the Academies invited to join, one only, the Royal Academy of History of Madrid, has as yet not replied to the request of the Wiesbaden Conference.

The provisional rules take into consideration the possibility of the addition of other learned societies, and in § 2 the conditions and formalities are indicated which will be necessary for the admission of a new Academy.

The Association comprises two Sections, the Section of Literature and the Section of Science. The work will be carried out by general meeting and committee. In principal, the general meeting will be held every three years, and each Academy will send as many delegates as it may deem necessary, but each Academy will have only one vote, which should be given by one of the members of the delegation.

In the interval between two general meetings, the Association is represented by the committee, each Academy being represented on this by one member only, if it concerns itself with only one of the Sections of Literature or Science; it will send two delegates when it is concerned with both Sections. Amongst the eighteen Academies, twelve belong to both Sections and consequently will send two delegates to the committee. Of the other six, four, namely the Royal Society of London, the Academy of Sciences of Paris, the Academy of Stockholm, and the National Academy of Washington, belong to the Section of Science alone, and two, the Academy of Inscriptions and Literature, and the Academy of Moral and Political Sciences, belong to the Section of Literature. Hence the

* Translation in *Nature* of a report made to the Paris Academy of Sciences by M. Darboux, permanent Secretary of the Academy, and published in the *Comptes rendus.*

committee will consist of thirty delegates, of which sixteen will belong to the Section of Science, and fourteen to that of Literature. In full committee the two delegates of one Academy will have only a single vote. After delay, in such cases, all the Academies, with the exception of two or three, have sent in the names of their delegates. The delegates of the principal Academy will take the chair at the committee of the Association, the principal Academy being that of the place in which it is proposed to hold the next general meeting.

The Conference of Wiesbaden having decided on a resolution to which we can here only draw attention, that the first general meeting of the International Association should be held in Paris this year, a difficulty has arisen not foreseen when the provisional rules were drawn up. Three Parisian Academies have joined the Association, it is necessary to decide to which shall be assigned the presidency on this occasion. The delegates of the three Academies of the Institute of France have met, and have unanimously decided to confer for this year the presidency of the Association upon the Academy of Sciences, which was the first to join the Association, and moreover, has taken an active part in the discussions, at the conclusion of which the Association was constituted.

It has been further decided that the first session of the committee shall be held in Paris towards the end of July, the first meeting being fixed for Tuesday, July 31st, at 9:30 a. m., at the Palais de l'Institut.

The agenda for the first meeting will include the preparation of a scheme of government for the committee, the settlement of the exact date and the order of the day for the next general meeting. The Royal Society of London, which has taken so active a part in the formation of the Association, has already announced a scheme which it proposes to submit for approval to this next general meeting; it concerns the measurement of an extended arc of a meridian in the interior of Africa.

The Academy, by the act of joining, has subscribed to the rules of the new Association. There is no occasion to recall here with what prudence and moderation they have been drawn up. The object of the Association is to prepare and promote scientific work of general interest which may be proposed by one of the constituent Academies, and generally to facilitate scientific relations between different countries. In any particular case, each Academy reserves to itself the right to give or refuse its support, or decide the choice of methods and the means to be employed.

If these principles are followed, the Association will become a powerful instrument of study, of concord and of scientific progress; it will rapidly take its place in the front rank of those international scientific associations, the *rôle* of which must necessarily be satisfactory.

Faithful to the principles which they have always followed, the three Academies of the Institute of France, called by the nature of their studies into the Association, will strive to assure it the success and influence which have been desired for it by its promoters.

Finally, attention may be directed to a particular clause in the rules which will interest some of our colleagues. For taking into consideration the study or preparation of scientific enterprises or researches of international interest, upon the proposition of one or more of the associated Academies, special international commissions may be instituted either by the general meeting or one of its two Sections or, in the interval between two general meetings, by the committee or one of its two sections.

*DEFECTIVE VISION OF BOARD SCHOOL CHILDREN.**

The London School Board have just tabulated the results of a test of the eyesight of school children in the Board schools. The object of the test was not to obtain statistical information or to satisfy scientific curiosity, but to achieve the practical end that children whose distant vision is defective should be placed in the front benches in the class room where they are required to see what is written or drawn on the blackboard. Some interesting results, however, have been obtained which are well worth the consideration of the medical profession and the attention of the parents of the children. The School Board at the end of last year requested the teachers to test the eyesight of the

* From the London *Times*.

children by means of certain testing cards, and to record the results. Sir Charles Elliott, who has taken great interest in the examinations, has appended an explanatory note to the return which has been made.

The manner in which the eyesight test was conducted, he states, was to hang up on the wall of the school, in a good light, the test card for distant vision and to mark on the floor a line at a distance of 20 feet from the wall. At this distance the children were required to read certain lines of letters. It appears, from a summary of the results, that of 338,920 children tested, 259,523, or 76.6 per cent., were found to have good sight, and 79,167, or 23.3 per cent., defective vision. The large number of 2675 children were only able to see the enormous top letter of the test card at a distance of 20 feet—a letter which is meant to be read at a distance of about 200 feet. The 79,167 children were given notices to their parents that they were suffering from 'serious defective vision' and advised to consult an oculist without delay. Taking the figures in the tables by School Board divisions it is seen that by far the largest percentage of defective vision is found in the city, where only 56.6 per cent. of the children have good sight. The other divisions where sight is below the average are Westminster (where the percentage of those having good sight is 67.7), Hackney (73.0), Tower Hamlets (74.0), Finsbury (74.3), and Southwark (74.9). Those in which the eyesight are above the average are Greenwich (which has a percentage of 82.2 having good sight), East Lambeth (78.7), West Lambeth 78.9), Chelsea (77.3), and Marylebone (77.1). In these latter divisions the houses are less dense and there are larger open spaces than elsewhere.

The figures, therefore, as far as they go, seem to bear out the hypothesis of 'town vision' expounded by Mr. Brudenell Carter in 1895, or, in other words, it points to the injury to the sight being caused by living in thickly-populated areas, where the eye has little opportunity of being exercised in distant vision. Another curious result of the test is that the proportion of good sight increases as the children rise in the different standards, which broadly coincide with the ages of the children. The percentage of good vision in Standard I. is 70.8; in II., 74.9; in III., 77.0; in IV., 78.9; in V., 80.3; in VI., 81.3; in VII., 82.9; and in ex-VII., 83.7. So that without a single break the ratio rises with the standard as the age of the children increases. But it may be doubted whether this means an increase in the power to see or only in accuracy of reading. Sir Charles Elliott expresses the belief that the recorded rise is contrary to general medical experience, and throws some doubt on the value of the whole statistics. Mr. Bland, of the Royal London Ophthalmic Hospital, he says, suggests the explanation that the bad results are partly due to weak power of reading rather than weak sight. "The trained eye is better able to discern letters than the untrained eye, and it is probable that the children in the higher standards achieved better results partly on account of their training."

The eyesight of girls appears to be inferior to that of boys, and Mr. Carter, in the inquiry made by him, seems to have arrived at similar results and to be inclined to account for them by the strain of needlework on the eyes of girls. Professor W. Smith, in a note appended to the Board's return, states that he had seen Mr. E. Clark, surgeon to the London Ophthalmic Hospital, in connection with the results, and they agreed that a similar return should be made of the available figures for near vision; that the figures were most interesting and valuable as giving the first experience on a large scale of the extent of defect of vision amongst children of school age; and that the figures showed that rather more than a fourth of the children suffered from defective vision. The London School Board proposes to repeat the test, year by year, in order to secure a correct record being kept of the progressive improvement, or the reverse, in the children's power of distant vision.

PROTECTION OF WILD ANIMALS IN AFRICA.

The London *Times* has received the following letter, dated May 10th, from a correspondent at Beira, East Africa:

I venture to bring before your notice the pressing danger that before long the districts which lie behind Beira, and which formerly teemed with game, will be denuded of all game through indiscriminate shooting. When the railway was commenced between Beira and Umtali buffalo existed in vast herds, and hartebeeste, wildebeeste, sable antelope, eland, and many other antelope existed in profusion. The railway is now completed and is simply a line running through the veldt, and would not of itself interfere with the game. At present there is but little game close to the line, but game of all sorts still exists in great but much diminished numbers some few miles away. The reasons for the disappearance of the game are as follows:—

1. The shooting of game for food by the *employés* of the line and the reprehensible practice of shooting for mere slaughter or for horns. In so far as shooting for the pot is concerned this is legitimate, as fresh meat cannot otherwise be obtained. Unfortunately the use of the .303 rifle is harmful, as animals are more frequently wounded by this rifle than killed, and go off into the veldt to die. Even with the soft-nosed or Jeffrey split bullet the shock is not severe enough to always bring the animal down and therefore this rifle compares unfavorably with the old Martini-Henry. The magazine .303 is simply a temptation to slaughter. During the past two years there have been a large number of *employés*, and the canteens have been pushed for food. It is the practice of canteen keepers at Bamboo Creek, which is in the center of the game district, to send not only white hunters but also natives to shoot; obviously the result is disastrous.

2. The advent of numerous hunting parties in the season, which extends from about June to December, during the early part of which many of the antelope are in young. These parties without exception go in for indiscriminate slaughter, and if allowed to continue will denude the whole country of game.

3. The rinderpest, which visited this country in 1898, killed off thousands of the buffalo, and nearly exterminated the eland and sable antelope.

The district in question is not cultivated and can only be of use as a hunting district. I have reason to believe that if properly approached, the Mozambique Company would be willing to establish a close season, or even close down the shooting for four or five years. There has now been established in Beira a cold storage company which will shortly commence operations, and thus every one on the line will obtain meat. Also after this year, the contract for the railway having been completed, there will be a far smaller population requiring meat.

Last year, owing to a very prolonged rainy season and the disturbed state of South Africa, there were very few hunting parties, and this year there will be practically none, owing to the war, so that the game have now a chance of increasing in number; but unless another five years of close time are allowed, followed by a rational system of close seasons, they will have but a small chance of getting up to the number they were at only three years ago. This applies especially to the buffalo, eland and sable antelope.

I would suggest that the hunting parties be strictly supervised and limited to a small number of heads; also that a long close season be established, and that buffalo, eland, and sable antelope be made Royal game for some years to come; also that natives be prevented from shooting.

I have reason to believe that the Mozambique Company would not object to employ gamekeepers, but there is no hope of the company ever doing anything on their own initiative.

This part is one of the few accessible spots where the larger kind of antelope can be found and it is more than a pity to see these beautiful animals slaughtered as they are now. In the interest of true sport the indiscriminate shooting of the past three years should be stopped. The months November and December should be the only months in which shooting is allowed. The grass having been burnt off there is less likelihood of wounding instead of killing, and by this time all the young have been dropped.

SCIENTIFIC NOTES AND NEWS.

WE wish to call special attention to the letter from Dr. Richard Rathbun, on the International Catalogue of Scientific Literature published above. It is absolutely necessary that forty-five sets be subscribed for in America, and it is desirable that this be done before the beginning of October.

THE judges who are to select 100 eminent Americans, whose names are to be engraved in the Hall of Fame of the New York University, are ready to receive nominations. The following men of science have been proposed: John Adams Audubon, Spencer F. Baird, Alexander D. Bache, Nathaniel Bowditch, William Chauvenet, Henry Draper, James P. Espy, Asa Gray, Robert Hare, Joseph Henry, Edward Hitchcock, Isaac Lea, Matthew Fontaine Maury, Marie Mitchell, Benjamin Peirce, David Rittenhouse, Benjamin Silliman, Benjamin Thompson, John Torrey. Are any of the readers of this JOURNAL prepared to suggest how many men of science should be included among the 100 most eminent Americans no longer living, and who they should be?

DR. CARL GEGENBAUR, professor of anatomy at the University of Heidelberg, has retired from the active duties of his professorship.

IT will be remembered that at the Twelfth International Medical Congress, held at Moscow in 1897, the city established a prize of $1000 to be conferred at each Congress on the one who since the preceding Congress had done the medical work of the greatest benefit to humanity. The first award of the prize was to M. Henri Dunant, founder of the Red Cross Society. At the present Congress, the award has been made to Professor Rámon y Cajal, for his researches on the minute structure of the nervous system.

THE Faculty of Science of the University of Rome proposes to publish by subscription a complete collection of the works of the late Professor Eugenio Beltrami. It will extend to three or four large volumes, and will be sent to those subscribing $10 or more towards the cost of publication.

THE Berlin Academy of Sciences has made further grants as follows: Dr. Holtermann, Berlin, for a botanical expedition to Ceylon, 4000 Marks; Professor Ludolf Krehl, Greifswald, for experiments on respiration, 1500 Marks; Professor Julius Tafel, Würzburg, for the continuation of his work on electrolysis, 100 Marks; Dr. Benno Wandolleck, Dresden; for the investigation of the morphology of diptera, 800 Marks.

PROFESSOR B. E. FERNOW, of the Cornell College of Forestry, has been appointed delegate to the International Forestry Congress of the Paris Exposition.

PROFESSOR FELIPE VALLE, of Mexico City, connected with the Tacubaya Observatory, is on his way to Europe, where he will represent the Mexican Government at certain of the congresses held during the Paris Exposition.

THE Royal College of Physicians has made the following appointments: Professor Clifford Allbutt, regius professor of physic at Cambridge, will deliver the Harveian oration on October 18th (St. Luke's Day); and Dr. A. E. Garrod, of St. Bartholomew's, the Bradshaw lecture in November. Dr. Henry Head has been appointed the Goulstonian, Dr. J. Frank Payne the Lumleian, and Dr. Halliburton the Croonian lecturer for 1901, and Dr. J. W. Washbourn the Croonian lecturer for 1902.

DR. ADALÁR RICHTER, professor of botany at the University at Klausenberg, has been made director of the Botanical Institute and of the Botanical Garden.

THE Moxon gold medal, of the Royal College of Physicians, founded in 1886 in memory of the late Dr. Walter Moxon, and awarded every third year for distinction in clinical medicine, was awarded to Sir William Tennant Gairdner, M.D., F.R.S., emeritus professor of medicine in the University of Glasgow.

DR. HERMANN A. LOOS died of yellow fever on the steamship *Chile* on July 17th, while on his way to South America. Dr. Loos received the degree of doctor of philosophy from Columbia University this year for work in chemistry and was offered the position of assistant in the University. He was only 24 years of age.

WE regret also to note the deaths of Dr. Johann Kjeldahl, director of the chemical laboratory at Karlsberg, and of Dr. Wilhelm Keck, professor of engineering at Hanover.

THE Comptroller of the City of New York has refused to pay most of the bills presented by experts in the Mollineux trial. Some of the bills are as follows: Dr. R. A. Witthaus, chemist, $18,550; E. J. Lederle, chemist, $3800; E. S. Potter, a physician, $2450; Dr. Persifor Fraser, handwriting expert, $2181. There are some eight handwriting experts who present bills each larger than a thousand dollars.

THE annual meeting of the Corporation of the Marine Biological Laboratory was held at Woods Holl, on Tuesday, August 14th.

THE New York *Medical Record* contains a cabled report of the 13th International Medical Congress which met at Paris from the 2d to the 9th of August. M. Lannelongue, president of the Congress, made an opening address which was followed by speeches by the presidents of the National Committees, including Lord Lister, Professor von Bergmann, of Berlin, and Professor Kitasato, of Japan. General addresses before the Congress were made by Professor Virchow, of Berlin, Professor Burdon-Sanderson, of Oxford, and Professor A. Jacobi, of New York. The registration at the Congress numbered 6170 of which 412 were Americans.

WE have already called attention to the first International Congress of Physics which opened at Paris on August 6th. The Congress was divided into the seven following sections, which met in the rooms of the Société française de Physique: (1) general questions, instruction, measurements; (2) mechanical and molecular physics; (3) optics; (4) electricity and magnetism; (5) magneto-optics, radio-activity, discharges in gases; (6) cosmical physics; (7) biological physics. *Nature* states that among the subjects dealt with by British physicists are: the movements produced in an indefinite solid by the displacement of a material body, by Lord Kelvin; the constant of gravitation, by Mr. C. V. Boys; the propagation of electricity, by Professor Poynting; electric discharges in gases, by Professor J. J. Thomson; properties of alloys, by Sir W. C. Roberts-Austen; and the unit of heat, by Mr. E. H. Griffiths. In addition there are contributions by Professors Lorentz, van't Hoff, Warburg, Voigt, van der Waals, H. Poincaré, Cornu, Lippmann, Potier, Becquerel, Arrhenius, Exner, Spring, and others.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler, at the Lick Observatory, stating that the following elements and ephemeris of comet 1900b were computed by Perrine from observations on July 25th, July 30th and Aug. 4th.

Time of passing perihelion	$= T =$ Aug. 3.21
Perihelion minus node	$= \omega = 12° 27'$
Longitude of node	$= \Omega = 328° 1'$
Inclination	$= i = 62° 31'$
Perihelion distance	$= q = 1.0148.$

Ephemeris.

1900.			1900.		
Aug. 10,	R.A.	$3^h15^m16^s$	Decl.	$+63° 41'$	Light 0.83
" 14,	"	3 34 44	"	+72 17	
" 18,	"	4 12 28	"	+79 11	
" 22,	"	5 46 24	"	+84 11	Light 0.43

THE U. S. council at St. Gall, Mr. Du Bois, sends to the Department of State the following account of the trial of the Zeppelin air ship: At the invitation of Count Zeppelin, I was present at the trial ascent of his air ship on the afternoon of July 2d at Manzell, on Lake Constance. At 7 o'clock the great ship, 407 feet long and thirty-nine feet in diameter, containing seventeen separate balloon compartments filled with hydrogen gas, was drawn out of the balloon house securely moored to the float. At the moment of the ascent the wind was blowing at a rate of about 26 feet per second, giving the operators a good opportunity of testing the ability of the air wheels to propel the great ship against the wind. The cigar-shaped structure ascended slowly and gracefully to about 30 feet above the raft. The balances were adjusted so as to give the ship an ascending direction. The propellers were set in motion, and the air ship, which has cost considerably over $200,000, started easily on its interesting trial trip. At first, the ship moved east against the wind for about two miles, gracefully turned at an elevation of about 400 feet, and, making a rapid sail to the westward for about five miles, reached an altitude of 1300 feet. It was then turned and headed once more east, and traveling about a mile against the wind blowing at the rate of twenty-six feet per second, suddenly stopped; floating slowly backwards three miles to the west, it sank into the lake, the gondolas resting safely upon the water. The time of the trip was about fifty minutes; distance traveled, about ten miles; fastest time made, five miles in seventeen and one-half minutes; highest possible revolution of the propellers, 600 per minute. The cause of the sudden stoppage in the flight of the ship was proved to be a slight mishap to the steering apparatus, but the colossus floated gently with the wind until it settled upon the surface of the lake without taking any water. The raft was then brought up and the ship was easily placed upon it and brought back to the balloon house. The weight is 200 centners (22,000 pounds).

A CORRESPONDENT writes to the London *Times:* The International Congress of Hygiene and Demography is to meet this year in Paris from the 10th to the 17th of August, corresponding exactly in date with the meeting held nine years ago in London. Forming as it does one of a succession of congresses that are being held in Paris during the Exposition, it cannot perhaps be expected to arouse the same attention as the meeting in 1891, under the presidency of the Prince of Wales and the chairmanship of Sir Douglas Galton. During the nine years that have passed since the London meeting the science of hygiene has steadily developed, and the reports to be presented to the Paris meeting include questions that had hardly been formulated in 1891, and many that have claimed a great deal of attention in the past few years, such as bacteriology, prevention of tuberculosis, preservatives in food, and school hygiene. The program set out for the nine sections into which the work of the congress is divided covers a very wide field, showing how intimately hygiene enters into every branch of life. The several sections include —(1) bacteriology; (2) hygiene of alimentation, and chemical and veterinary science; (3) engineering and architecture; (4) personal hygiene and the hygiene of communities (schools, hospitals, prisons), cremation; (5) hygiene of professions and trades (unhealthy dwellings); (6) military, naval and colonial hygiene; (7) general and international hygiene, infectious diseases and sanitary legislation and administration; (8) hygiene of travelling and communications (railways, ships, public conveyances); and (9) demography. It is to be wished that there had also been a section for the discussions of poisons used in personal decoration and not only of those used for hair dyes, etc., but of the poisons used in boot polish, especially that for brown boots, by means of which feet have been seriously injured. In view of our recent and present experience of armies in the field, the section dealing with military hygiene should offer a good opportunity for the elucidation of various vexed questions in field organization and equipment. The late Sir Douglas Galton would have seized such an occasion for the deduction of practical results. His position on the Army Sanitary Committee of the War Office enabled him to effect many reforms, but he would have availed himself to the utmost of the opportunity which the Paris congress now offers to call attention to the many points in our South African experience which seem to demand further improvement. The Prince of Wales, in his admirable address at the opening of the congress in 1891, dwelt in forcible terms upon the lessons which might be learned in every life, private as well as public, from the study of the causes of the insidious progress of enteric fever, and it is especially interesting at the present moment to recur to those facts and to note with what acute perception His Royal Highness foresaw the perils of that illness which has assumed such formidable proportions, and which has caused such loss of life in our forces. It is a matter of great satisfaction that the president of the Hygiene Congress at Paris this year is M. Brouardel. No one will command greater confidence from his wide and scientific knowledge of hygiene. M. Brouardel was present at the congress of 1891 and he also attended the meeting of the British Association at Dover in 1899. He is therefore well known to the British public. Under the auspices of so able a president the Congress of Hygiene at Paris should maintain the high position in which it was placed by Sir Douglas Galton at the Congress of 1891.

UNIVERSITY AND EDUCATIONAL NEWS.

COLORADO COLLEGE has secured $100,000 for a new science building.

LORD BUTE has offered to give $20,000 to the

University of St. Andrews for the endowment of a chair of anatomy. His gift is made under the condition that the University make adequate provision for the first two years of a course in medicine. Mr. Musgrove, the present holder of the lectureship of anatomy at St. Andrew's, is to be the first incumbent of the new chair.

The *Nation* quotes from the *Zeitschrift für Philosophie und Pädagogik* certain conditions prevailing at the German universities regarding admission to the examinations for the degree of Doctor of Philosophy. In all the twenty-one universities of the Empire, the gymnasium graduates are permitted to take examinations in all the departments of the philosophical faculty, while there is no agreement, not even in the universities of the same country, with reference to the promotion of the graduates of the Realgymnasia or the Oberrealschulen; the Real or purely scientific non-classical graduates being nowhere allowed to become candidates for degrees. Those who have completed the semi-classical Realgymnasia are admitted to examinations in twelve universities (of these six are in Prussia), in all departments of the philosophical faculty, while eight admit them in modern languages, mathematics, and natural sciences; and one, the University of Erlangen, only in mathematics and natural sciences. The Oberreal-school graduates (in those institutions the scientific studies strongly predominate) are admitted to the philosophical doctorate in all sections only by Greifswald, in five universities only in natural sciences and mathematics; and in ten (among these six are in Prussia) they are not admitted to a degree at all. Two universities have not yet taken final action in the matter. In view of this, the action of the German Realschul Association, representing the interests of the higher non-classical education in Germany, at the recent convention in Berlin is of interest. At this meeting, attended by more than three hundred philologians, a petition, originally drafted by the National German Society of Engineers, and signed by 12,000 names, was adopted, asking that the graduates of all the nine-year secondary schools, *i. e.*, the Gymnasia, the Realgymnasia, and the Oberrealschulen, should alike and without discrimination be admitted to university privileges and degrees, and that in future the lowest three classes in all the schools of this kind should have the same non-Latin courses. This petition has been presented to the Cultus-Minister of Prussia.

Dr. Alwyn S. Wheeler, Ph.D. (Harvard), has been elected to the assistant professorship of chemistry in the University of North Carolina.

The following have been elected professors and lecturers of Royal College of Surgeons of England for the ensuing collegiate year: Hunterian Professors, Mr. Charles Stewart, M.R.C.S. Eng., F.R.S., Mr. Percy Furnivall, F.R.C.S. Eng., L.R.C.P. Lond., and Mr. Christopher Addison, F.R.C.S. Eng., M.D., B.S. Lond., L.R.C.P., Lond., Arris and Gale lecturer, Mr. T. G. Brodie, M.R.C.S. Eng., M.D. Lond., L.R.C.P. Lond., Erasmus Wilson, lecturer, Mr. Walter Edmunds, F.R.C.S. Eng., M.B., M. C. Cantab. Mr. S. G. Shattock, F.R.C.S. Eng., was re-elected pathological curator, and Mr. R. H. Burne was re-elected anatomical assistant in the museum.

The registration at the first summer session of Columbia University was 417. The attendance consisted of 114 men and 303 women of whom about 80 per cent. were teachers.

Mr. F. P. Spalding, a graduate of Lehigh University, who has been instructor in that University and in Cornell University and has recently been acting as a professional engineer, has been appointed professor of civil engineering in the University of Missouri.

Dr. J. C. Shedd, instructor in physics at the University of Wisconsin, has accepted the professorship of physics at Colorado College, to succeed Dr. S. J. Barnett, who goes to Stanford University.

Dr. Walter E. Garrey formerly assistant in the department of physiology of the University of Chicago, has been elected to chair of physiology in Cooper Medical College, San Francisco, Cal. This summer he was one of the instructors in the course in physiology at the Marine Biological Laboratory, Woods Holl, Mass.

SCIENCE

Friday, August 24, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE MISSION OF SCIENCE IN EDUCATION.**

The average graduate from an American university needs no counsel as to his conduct when he comes to face 'the untried world.' He has had his eyes open, and has tried the world more or less, often too much; and has already been surcharged with advice from those of larger experience. If he does not know the elements of success, it is not because he has failed to hear of them; and it only remains for him to receive the teaching which comes from experience. I address these graduates, therefore, with the consciousness that it is too late to add effective advice, and too early to appeal to their experience. I come, therefore, not to youths who are about to be sent away for the first time from the fostering care of a mother, but to university men and women, interested in whatever concerns higher education, and I wish to speak to them of the mission of science in education.

In its broadest sense science includes all knowledge, but the reference here made is to the ordinary application of the word in schemes of education. Perhaps even this needs limitation, if by chance any one has confused reading about science with scientific training; for reference is made to science taught by the laboratory method, which merely means direct and personal contact with the subject matter.

* An address delivered at the annual commencement of the University of Michigan, June 21, 1900.

The advent of science, as thus defined, into schemes of college and university education, was unpromising. It was like one born out of due season, for whom there is no place or preparation. The courses of study were already filled with subjects, all of which naturally seemed to be far more important than the interloper, who had to be content for a time with the crumbs which fell from the already crowded table. Scraps of time and information rather than training was not a happy combination to develop an educational result from any subject, and least of all from science. The general attitude at first towards the laboratory method is well illustrated by the experience of Rafinesque, the first teacher west of the Alleghanies who attempted to introduce it. From 1823 to 1826 he was professor of modern languages and the natural sciences in Transylvania University, in Lexington, Kentucky. In his botanical instruction he ventured to bring plants into the recitation room, which was objected to by the Faculty as 'tending to produce disorder among the students, and to convert a serious recitation into the mere examination of curiosities, thus wasting valuable time.'

After science had secured a definite place in the colleges and was making its first feeble attempts at laboratory work, it was confronted by an obstacle more serious than scraps of time, an obstacle which still exists in certain quarters, either in fact or in spirit. Instead of being admitted to equal rights in a republic of subjects, it was degraded by the organization of so-called scientific courses, which were confessedly inferior to the others; and as if to insure a weak result the scientific course was often made shorter than the others. In my own college, but a type of the great majority of colleges in those days, a student who was not strong enough to graduate in four years in the classical course could graduate in three years in the scientific course. No self-respecting student could afford to be a 'scientific' under such conditions, so that only the weaklings, with three-fourths of the legitimate time at their command, became the exponents of the advantages of scientific training! All those who are middle-aged can testify to a similar college experience, and the result was a deep-seated distrust of the value of science in education, an honest contempt for its results, which distrust and contempt have been handed down to the children now in college, so far as they are being influenced by parental advice. This result is natural, and I have no word of blame for those who possess the feeling, but the conditions which developed it were simply inexcusable.

In spite of the unfortunate conditions which accompanied the advent and much of the history of science in education, it has now become firmly established, has a reasonable rank and allotment of time, and is in a position to show what it has done and what it can do for education. Time enough has not yet elapsed, and absolute equality has not yet been sufficiently attained to permit the fullest expression of legitimate results, but in some degree and at some universities the results are beginning to be apparent. It is hard for one to appreciate 'the mighty power of what has been over the frail form of what might be,' so that sentiment as yet unconsciously influences the judgment even of the fair-minded. But certain results of the presence of science in education seem to be evident enough, and a few of these I propose to present in the form of definite propositions.

1. *Science has revolutionized educational methods.*—This proposition needs no special defence, as it seems to be well nigh universally admitted. In fact, it is the pride of almost every subject to-day that it is taught by the laboratory method. This simply means that the old recitation, which was the retailing of second-hand informa-

tion as to facts, and of second-hand opinions concerning them, has given place to the direct observation of facts and the expression of individual opinion concerning their significance. As a result, students are sought to be made thinking rather than memorizing machines, with the initiative power developed rather than the imitative.

Even in the study of literature, the very stronghold of the cult organized by the humanities, the books about literature have been banished, and the contact is with literature itself. The legitimate offspring of the laboratory is the seminar, and even in the most elementary work the laboratory idea of presentation prevails. In short, the introduction of the laboratory started the movement which has resulted in more rational methods of teaching in every department of college activity. It was my good fortune to be a member of the college association of a neighboring State during the whole period of this evolution of methods, and it well exemplified the three successive attitudes of mind which Agassiz said were always apparent when a new and somewhat startling conclusion of science was announced. At first people say it is not true; later it is contrary to religion; and last everyone knew it before. So in the later stages of my experience I have been interested in hearing that every real teacher uses the laboratory method, and that science has no special claim upon it. And this is true in the sense that its claim is now merely a historic one. Every result which comes merely from the method may be duplicated by non-scientific subjects, for teaching in general has become scientific. The present and future value of science in education, therefore, cannot come from its peculiar methods, but from something inherent in the subject itself. I am glad to make this statement emphatic, for it is often said that the mission of science in education is to teach the laboratory method. Incidentally it did fulfill this mission, but if that were all it could now be banished without weakening our schemes of education.

1. *It develops the scientific spirit.*—By the scientific spirit I mean a certain attitude of mind. What this attitude is may be indicated by noting some of its characteristics.

(1) *It is a spirit of inquiry.*—In our experience we encounter a vast body of established belief in reference to all important subjects, such as society, government, education, religion, etc. It is well if our encounter be only objective, for it is generally true, and a more dangerous fact, that we find ourselves cherishing a large body of belief, often called hereditary, but really the result of early association. Nothing seems more evident than that all this established belief which we encounter belongs to two categories: (1) the priceless result of generations of experience, and (2) heirloom rubbish. Unfortunately, the discovery of the latter has often resulted in weakening the hold of the former. The young inquirer, or the non-logical inquirer is in danger of condemning all the conclusions of the past when one is found wanting. Towards this whole body of established belief the scientific attitude of mind is one of unprejudiced inquiry It is not the spirit of iconoclasm, as some would believe; but an examination of the foundations of belief. The spirit which resents inquiry into any belief, however cherished, is the narrow spirit of dogmatism; and is as far removed from the true scientific attitude as the shallow-minded rejection of all established beliefs. The childhood of the race accumulated much which its manhood is compelled to lay aside, and the world needs a thorough going over of its stock in trade. Such work cannot be done all at once, or once for all, for it must be a gradual sloughing off as the spirit of inquiry becomes more generally diffused. It must become

evident that this spirit is diametrically opposed to intolerance, and that it can find no common ground with those who confidently and sometimes violently affirm that the present organization of society is as good as it can be; that the present republics of the world represent the highest possible expression of man in reference to government; that the past has discovered all that is best in education; that the mission of religion is to conserve the past rather than to grow into the future. This is not the spirit of unrest, of discomfort, but the evidence of a mind whose every avenue is open to the approach of truth from every direction. Like the tree, it is rooted and grounded in all the eternal truths that the past has revealed, but is stretching out its branches and ever renewed foliage to the air and the sunshine, and taking into its life the forces of to-day.

Dogmatism still finds numerous victims, for education has not yet touched the majority, but everyday the possible victims are becoming fewer in number, and those who seek to lead opinion must presently abandon the method of bare assertion. The factors in this general intellectual progress are perhaps too subtle and interwoven to analyze with certainty, but conspicuous among them is certainly the development of scientific training.

For fear of being misunderstood, I hasten to say that this beneficent result of scientific training does not come to all those who cultivate it, any more than is the Christlike character developed in all those who profess Christianity. I regret to say that even some who bear great names in science have been as dogmatic as the most rampant theologian. But the dogmatic scientist and theologian are not to be taken as examples of 'the peaceable fruits of righteousness,' for the generel ameliorating influence of religion and of science are none the less apparent. It is not the speech of the conspicuous few that is thus leavening the lump of human thought, but the quiet work of thousands of teachers.

(2) *The scientific spirit demands that there shall be no hiatus between an effect and its claimed cause, and that the cause claimed shall be adequate.*—It is in the laboratory that one first really appreciates how many factors must be taken into the count in considering any result, and what an element of uncertainty an unknown factor introduces. In the very simplest cases, where we have approximated certainty in the manipulation of factors to produce results, there is still lurking an element of chance, which simply means an unknown and hence uncontrolled factor. Even when the factors are well in hand, and we can combine them with reasonable certainty that the result will appear, we may be entirely wrong in our conclusion as to what in the combination has produced the result.

For example, we have been changing the forms of certain plants at will, by supplying in their nutrition varying combinations of certain substances. By manipulating the proportions of these substances we produce the expected results. It was perhaps natural to conclude that the chemical structure of these particular substances produces the result, and our prescription was narrowed to certain substances. Now, however, it is discovered that the results are not due to the chemical nature of the substances, but to a peculiar physical condition which is developed by their combination, a condition which may be developed by the combination of other substances as well; so that our prescription is much enlarged. In this operation we are thus freed from slavery to particular substances, and must look only to the development of a particular physical condition. It seems to me that there is a broad application here. In education, we are in danger of slavery to subjects. Having observed that certain ones may be used to produce certain results, we prescribe them as essential to the process, without taking into account the possibility that other subjects may produce similar results.

In religion, we are in danger of formulating some specific line of conduct as essential to the result, and of condemning those who do not adhere to it. This is the essence of formalism, and its logical outcome, unchecked by common sense, is illustrated by the final expression of Jewish temple worship.

That there may be many lines of approach to a given result, if that result be a general condition, is a hard lesson for mankind to learn.

If it is so difficult to get at the real factors of a simple result in the laboratory, and still more difficult to interpret the significance of factors when found, in what condition must we be in reference to the immensely more difficult and subtle problems which confront us in social organization, government, education, and religion, especially when it is added that the vast majority of those who have offered answers to these problems have had no conception of the difficulties involved in reaching absolute truth. It is evident that in the vast problems which concern human welfare in general we are but groping our way, and that our answers as yet are largely empirical. The proper effect of such knowledge is not despair, but a receptive mind. In my judgment, therefore, the diffusion of the scientific spirit will make it more and more difficult for any one with a *nostrum* to get a hearing.

The prevailing belief among the untrained is that any result may be explained by some single factor operating as a cause. They seem to have no conception of the fact that the cause of every result is made up of a combination of interacting factors, often in numbers and combinations that are absolutely bewildering to contemplate. An enthusiast discovers some one thing which he regards and perhaps all unprejudiced and right-thinking people regard as an evil in society or in government, and straightway this explains for him the whole of our present unhappy condition. This particular tare must be rooted up, and rooted up immediately, without any thought as to the possible destruction of the plants we must cultivate. The abnormal tissue must be destroyed without reference to the fact that the method of destruction may debilitate the normal tissue.

This habit of considering but one factor, when perhaps scores are involved, indicates a very primitive and untrained condition of mind. In the youth of science it often threw its votaries into hostile camps, each proclaiming rival factors; when the problem really demands all the factors they all had and many more besides.

It is fortunate when the leaders of public sentiment have got hold of one real factor. They may overdo it, and work damage by insisting upon some special form of action on account of it, but so far as it goes it is truth. It is more apt to be the case, however, that the factor claimed holds no relation whatsoever to the result. This is where political demagoguery gets in its most unrighteous work, and preys upon the gullibility of the untrained, and is the soil in which the noxious weeds of destructive socialism, charlatanism, and religious cant flourish.

It is needless for me to enlarge the horizon of illustration, by including numerous fields of human thought and activity, for your own thought outruns my statement, and recognizes the conditions in every direction. It is to such blindness that scientific training is slowly bringing a little glimmer of light, and when the world one day really opens its eyes, and it is well if it opens them gradually, the old things will have passed away.

(3) *The scientific spirit keeps one close to the facts.*—One of the hardest things in my teaching experience has been to check the tendency of many students to use one fact as a starting point for a flight of fancy which is simply prodigious. Such a tendency is corrected of course when facts accumulate somewhat, and flight in one direction is checked by a pull in some other direction. But most of us have the tendency, and the majority are so unhampered by facts that flight is free. This exercise is beautiful and invigorating if it is recognized to be just what it is, a flight of fancy; but if it results in a system of belief it is a deception. There seems to be abroad a notion that one may start with a single well-attested fact, and by some logical machinery construct an elaborate system and reach an authentic conclusion, much as the world has imagined for more than a century that Cuvier could do if a single bone were furnished him. The result is bad, even though the fact have an unclouded title. But it too often happens that great superstructures have been reared upon a fact which is claimed rather than demonstrated.

We are not called upon to construct a theory of the universe even upon every well-attested fact, and the sooner this is learned the more time will be saved and the more functional will the observing powers remain. Facts are like stepping stones; so long as one can get a reasonably close series of them he can make some progress in a given direction, but when he steps beyond them he flounders. As one travels away from a fact its significance in any conclusion becomes more and more attenuated, until presently the vanishing point is reached, like the rays of light from a candle. A fact is really only influential in its own immediate vicinity; but the whole structure of many a system lies in the region beyond the vanishing point.

We *must* wonder what lies beyond, we must try our wings in an excursion now and then, but very much stress must never be laid upon the value of the results thus obtained.

Such 'vain imaginings' are delightfully seductive to many people, whose life and conduct are even shaped by them. I have been amazed at the large development of this phase of emotional insanity, commonly masquerading under the name of subtle thinking. Perhaps the name is expressive enough, if it means thinking without any material for thought. And is not this one great danger of our educational system, when special stress is laid upon training? There is danger of setting to work a mental machine without giving it suitable material upon which it may operate, and it reacts upon itself, resulting in a sort of mental chaos. An active mind turned in upon itself, without any valuable objective material, can certainly never reach any very reliable results.

It may not be that the laboratory in education is the only agency, apart from common sense, which is correcting this tendency: but it certainly teaches most impressively, by object lessons which are concrete and hence easiest to grasp, that it is dangerous to stray away very far from the facts, and that the further one strays away the more dangerous it becomes, and almost inevitably leads to self-deception.

There is no occasion for a further analysis of the scientific spirit or attitude of mind. It could be followed out into various ramifications of greater or less importance, but enough has been said to indicate its tendency. Nor is any further claim made at this point than for the laboratory method, for the scientific spirit is now being developed by subjects which are not grouped among the sciences as defined in this paper. It simply follows from the laboratory method, but as this came in by way of the sciences, and is still of easiest and most direct application in connection with them; so the characteristics of the scientific spirit indicated above are more easily and effectively developed in contact with the peculiar materials of science.

But I have still stronger claim to make for science as an essential constituent of all education, and that is

2. *It gives a training peculiar to itself, and one that is essential in every well-balanced education.*—The real educational significance of the training in laboratories devoted to science is very commonly overlooked, both by those who know nothing about it from personal experience, and even by those who are teachers of science. Many learn to go through the motions without appreciating the substratum of educational philosophy. Moreover, the knowledge of the educational significance of this special form of training has been slowly developed as the results have appeared.

Perhaps the earliest, and of course the most superficial form of statement explaining the purpose of scientific study was that it teaches the laboratory method. The inference was that the sciences are of no particular educational advantage in themselves, but are merely useful in teaching a valuable method. In so far as this emphasized the fact that reading or reciting about science cannot be regarded as training in science, and in so far as it recognized that science is to be credited with introducing a revolutionary and invaluable educational method, the statement is true enough; but to regard these purely incidental results as being in any sense the end of scientific training is far enough from the mark. The laboratory method holds no more relation to science than do algebraic symbols to algebra; they both merely represent useful machinery for getting at the real results. And further, as has been shown, if the teaching of a method is the only function of science in education, when this method has been learned and has become universally applied, the mission of science in education is at an end.

Another commonly stated advantage of training in science is that it cultivates the power and habit of observation. This is certainly true, but with equal certainty this result is not peculiar to scientific training, for it belongs to the laboratory method, and appears whenever the method is applied to any subject. It may be claimed that the most direct and tangible materials for observation fall within the province of science, but this is a difference of degree rather than of kind, and therefore the result may be obtained apart from science. It is true that in the elementary stretches of education the methods are still prevailingly conventional, and therefore, stunt the natural powers of observation. The fine tentacles of inquiry which are put out in every direction by the child thus become atrophied, so that when later in his educational experience he is introduced into the laboratory he is as helpless as though transferred to a totally different set of life conditions. It takes almost a surgical operation to open his eyes, and he is apt to have lost not only the power but with it also the desire of observation. This wholesale and criminal mutilation of natural powers, however, is not the fault of the subjects studied, but of the conventional methods employed, which demand faith rather than sight, memory rather than reason, the sacrifice of truth to conventional ideas. To keep these important powers functional may still be an important mission of science in elementary education, but when the conventional method has been replaced by the natural in all subjects of study, this mission also will have been fulfilled, and will be recognized merely as an incident in scientific training.

Those who are accustomed to look a little beneath the surface before formulating a statement are very apt to be content with saying that the study of science trains in the power of analysis. This is certainly getting the subject upon higher ground, and suggests a result which is worthy of every effort. The power of analysis is one of immense practical importance, and the value of its cultivation will not be denied. To imagine, however, that analysis is the ultimate purpose of science, is not to go very much farther than to say that the ultimate purpose is the laboratory method. The latter is the method, the former is but the first step in its application. But even this step is by no means peculiar to science, for it is the initial one in the teaching of every subject. In our search, therefore, for the peculiar benefits of science in education, we are again compelled to look further.

Beyond analysis lies synthesis, and this certainly represents the ultimate purpose of science. The results of analysis are as barren as a bank of sand until synthesis lays hold of them. It is just here that a large amount of science teaching fails, for to many teachers the accumulation of unrelated facts seems to be the end of scientific study, and the results of the laboratory may be represented by a chaotic pile of brick rather than some definite structure dominated by an idea. Almost anyone may accumulate facts, but to relate them, to distinguish the significant and the insignificant, to recognize that they are merely external expressions of something general, belongs to the highest stretches of scientific training. May I be permitted to say, without being misunderstood, that the potent influence of the German laboratories upon American establishments has resulted in general in making our best investigators and our worst teachers. The influence is beneficent to the last degree in so far as it lays hold of a disposition to careless work and hasty generalization and holds it down to the patient collection of facts and their very cautious collection; but when it results in mere Gradgrind teaching all inspiration has evaporated, and the laboratory touches no more the finer mental powers than does a factory. The difference indicated finds its illustration in some of our best known texts, which are merely expressions of styles of teaching. In the one case the facts are presented in the helter-skelter fashion, solid and substantial enough, but a regular mob, with no logical arrangement, no evolution of a controlling idea. Details are endless, no emphasis brings out certain things into prominence and subordinates others, and the whole subject is as featureless as a plain, where the dead level of monotony kills off every one but the drudge. It is the spirit of analysis, a dead body of facts without a vitalizing spirit. In the other case fewer facts are presented, but they are the important ones, and marshalled in orderly array, battalion by battalion, they move as a great whole towards some definite object. The facts may fade away, even the battalions may grow dim, but the great movement remains definite and clear as a memory which is an inspiration. Instead of a level plain, there are mountain peaks and valleys, there is a perspective and there are vistas from every point of view. This is the spirit of synthesis, which vitalizes the great body of facts and makes them glow. To the teacher, in his work of training, an unrelated fact is worse than useless.

But even synthesis is not peculiar to science. To pass by the incidental and temporary and reach the real and permanent contribution of science to education is to discover that it lies not in teaching the laboratory method, in developing the power of observation, in cultivating the spirit of analysis, or even in carrying one to the heights of synthesis; but in the mental attitude demanded in reaching the synthesis. In this regard the demands of science are diametrically opposed to those of the humanities, for instance, using this loose term to express the great region of literature and its allies. The humanities have been and must continue to be a noble course of intellectual development, without which an education is certainly incomplete. It is the most ancient and best known form of culture, and being ancient and bound up with the intellectual development of mankind it must necessarily continue to hold high rank. The general effect of the humanities in a scheme of education may be summed up in a single word *appreciation*. They seek so to relate the student to what has been said or done by mankind, that his critical sense may be developed, and that he may recognize what is best in human thought and action. To recognize what is best involves a standard of comparison. In most cases this standard is derived and conventional; in rare cases it is original and individual; in no case is it founded in the essential nature of things, in absolute truth, for it is apt to shift. In any case the student injects himself into the subject; and the amount he gets out of it is measured by the amount of himself he puts into it. It is the artistic, the æsthetic, which predominates, not the absolute. It is all comparative rather than actual. The ability to read between the lines is certainly the injection of self into the subject-matter, and the whole process may be regarded as one of *self-injection* in order to reach the power of *appreciation*. My claim is that any education which stops with this result is an incomplete one, and that there is another mental attitude which is a necessary complement before a full-rounded education can be claimed; and that this complementary mental attitude is developed by a proper study of the sciences. If the study of nature is conducted so as to cultivate merely a sentimental appreciation of natural objects, it does not fall within the category I am considering, and can in no way be considered as a study which acts as a complement to the humanities. It is merely more of the same thing. If the proper intellectual result of the humanities is *appreciation*, whose processes demand *self-injection*, the proper and distinctive intellectual result of the sciences is a *formula*, to obtain which there must be rigid *self-elimination*. Any injection of self into a scientific synthesis vitiates the result. The standard is not a variable, an artificial one, developed from the varying tastes of man, but absolute, founded upon eternal truth.

Two such distinct mental attitudes as self-injection and self-elimination must receive attention in education, which cannot be complete without both. They are not contradictory, but complementary, and it takes both to make the 'all-round' man. The exclusive cultivation of either one must result in a lop-sided development. Persistent self-injection tends to mysticism, a confusion of ideals or even vagaries with realities, a prolific cause of all irrational beliefs. Persistent self-elimination narrows the vision to a horizon touched by the senses and clips the wings that would carry us now and then beyond the treadmill of life into a freer air and a wider outlook.

The one needs the other as a check. In their combination self-injection is held back from dangerous flights by the demand to feel something solid beneath the feet; and self-elimination is compelled to raise its eyes now and then from the ground and sweep the heavens.

In our analysis, however, we strip off the flesh and lay bare the skeleton, and are apt to lose sight of the fact that the contour is a composite result. Although the skeletons of the humanities and of the sciences may differ from each other in the fundamental way described, I cannot conceive of the resulting contour of the one as distinct from combination with the other. The self-eliminating result of science must be associated with the self-injecting result of the humanities, even though science alone be studied; and the power of appreciation developed by the humanities must always be tempered by the scientific spirit. And yet, the two processes and the two results are so distinct and so complementary that any scheme of education which does not provide for the definite cultivation of these two mental attitudes, and which leaves the complementary part merely to the chances of methods of teaching and mental structure, is in constant danger of resulting in mental distortion.

I have indicated in this very general way the broad principles involved in the mission of science in education. Numerous details might be presented which would justify the claims that have been made, and perhaps such details would have made my thesis more clear, and would have left me in less danger of being misunderstood; but neither the time nor the occasion will permit them.

There is a factor of such overwhelming importance in the effectiveness of the mission of science in education that I cannot forbear the mention of it, and that is the teacher. I have presented the possible, the ideal results, but they can be approximated only by the thoroughly competent teacher. The problem of the teaching of science in the universities is becoming a serious one. There is no need to include in this discussion the teaching of science in the schools, for those engaged in it are devoting their whole time and knowledge to its development. It is sadly true that as a rule they need more time and far more knowledge, but this need is being gradually met, and every year the teaching in the schools is becoming better. On the contrary, I am tempted to say that every year the teaching of science in the universities is becoming worse. Perhaps the statement is too strong, but it expresses a tendency, that must be checked. The university instructor is confronted by two serious duties; he is to instruct, and he is to produce. In the constitution of American universities the primary function of the instructor is to instruct; and, if time and strength permit, the secondary function is to produce. From the theoretical standpoint production is essential to a thoroughly good university instructor, for production makes all the difference between a pump and a perennial spring. There is no special inspiration in the continual retailing of second-hand information. Practically, however, the conscientious teacher must expend all his energy, or at least all his effective energy upon teaching and faculty duties. The logical outcome is that teachers who wish to investigate cease to be conscientious as teachers. Production becomes the principal thing, and instruction a mere incident. It might be expected that these unconscientious teachers would be gradually eliminated, but there are two facts which not only prevent the elimination but increase the evil. The first is that in large universities the tenure of office is practically unlimited, and if the instructor is making a name through production his tenure of office is not likely to be terminated, however bad his teaching. The second fact is that in the appointment of new instructors the universities to-day are looking more for productive power than for teaching power. This latter fact reacts seriously upon those who are preparing for university positions, and their whole training is upon problems connected with their subject, to the entire exclusion of those connected with its presentation. In short, my claim is that in the universities our instructors have been trained to investigate rather than to teach. I have never met such wretched teaching anywhere as is daily permitted in the greatest universities. Under such conditions the instructor for a few years makes a spasmodic effort to teach, presently loses his interest in it, and gradually lapses into indifference.

It is a common statement that large universities are no places for undergraduates, as they are turned over to the younger instructors and do not meet the heads of departments. Theoretically this is a serious charge, but practically it is a wise arrangement, for in general it is true that the undergraduate would do well to beware of the old instructor, unless it is his wish to be neglected. The instructor who is a novitiate will work hard for him, even to the point of drudgery, even if he does not always work effectively.

I must not be misunderstood. Those who are born to teach will always teach when placed before a class, and every university has its share of such teachers, and the older they get, the more effective do they become; but I think I am right in claiming that the majority of instructors who have been brought into the universities within the last decade or two are teaching as an incident to investigation. I am not blaming these instructors, for I enter into their feelings most sympathetically. I am merely stating a problem which must be solved. We must have production or teaching will become a treadmill and real universities will have no reason for existence; but we must also have effective teaching. The problem is, how can we have both? The answer is simple, but hard of application, for it involves the natural limitations of men, which they are slow to recognize. Some are born to teach and some are born to produce, and these two classes should be recognized and utilized by the University, but self-recognition is more difficult. As it is, every instructor feels upon himself a pressure to produce, for it is in the atmosphere to-day; but in the majority of cases yielding to this pressure involves a waste of valuable time and energy without any adequate result. Such instructors are unwilling to acknowledge, even to themselves, that they have not the initiative for profitable investigation, whatever may have been their preparation.

On the other hand, the born investigator is nearly as slow to recognize that he is probably not a successful teacher. With born teachers trying to investigate, and born investigators trying to teach, and still others born to do neither, the average university becomes a good illustration of misdirected energy. If in any way the lines could be drawn so that the two classes could be recognized by themselves, as they already are by their associates, the problem would be solved.

In my judgment it would be fatal absolutely to restrict either to his own field, for the teacher, in his own interest rather than that of his subject, must produce enough to retain and develop his inspiration, and to appreciate the methods and results of investigation; while the investigator, in his own interest rather than that of his students, must teach enough to retain his breadth of vision and to cultivate the power of clear and apt expression.

In connection with any claim for the great and peculiar contributions of science to education, it seems pertinent to refer to a complaint heard now and then that the encroachment of science upon university attention has changed the atmosphere from one that is literary to one that is commercial. A common phrase is: 'the commercializing tendency of modern education.' The idea seems to be that a certain fine flavor of thought and expression is becoming less evident, and that the somewhat indefinite but soaring balloon is being replaced by the locomotive. Without calling attention to the fact that if one wants to get anywhere at any definite time the locomotive is more effective than the balloon, and without inquiring into the personal training or idiosyncracies of those who make the complaint, I wish to call attention to a probable explanation of the imaginary change.

The old education, which is reputed to have had such beneficent results, was a magnificent training; but it must never be forgotten that it was an example of extreme specialization. A narrow round of subjects was continually studied and all that can be claimed for specialization appeared in the result. Like all specialization, however, its effective application depended upon the mental aptitude of the student. As these aptitudes are quite varied, the old specialized education selected from the mass the few to whom it was adapted, and these became really educated and dominated the university atmosphere, their more numerous fellows falling out unnoticed in the unequal race. And so the flavor which belongs to this special kind of education became the universal flavor of the educated.

When new subjects appeared, and courses began to be multiplied, other students began to be selected from the mass and joined the society of the educated, and the old flavor ceased to be one peculiar to education in general.

The change, therefore, is simply that more students than formerly are reaching what may be called an education, and the difference is one of proportion, not of actual number. Opportunity for the old education is still with us, and those who are adapted still take advantage of it, and their number is greater than ever before. But they are compelled to acknowledge as brothers in the fraternity of the educated a host who had been excluded before through lack of opportunity. There is no longer an aristocracy in education, and the democracy of to-day demands that all who are trained, by whatever method, shall strike hands as brothers and equals.

In conclusion, may I be permitted to say that the full significance of scientific training will appear only when it begins in some form in the primary schools and touches the student at every stage of progress. Appealing as it does to the most natural tendencies of childhood, its greeting at the threshold of school experience is that of the one familiar friend, whose presence relates the young to things which they can see and handle, and saves them from that desolation of spirit and mental warping which comes from exclusive contact with the conventional and the intangible. The university owes a great service to the schools in this particular, and the tentacles of its influence must constantly be reaching delicately and inquiringly into school instruction. What the schools can do or cannot do, what they should do or should not do, are questions which cannot be answered in *ex cathedra* fashion. The wilful ignorance of many university instructors in reference to the work of schools upon which they depend is amazing. The university as a whole recognizes and encourages the intimate relationship, but only an instructor here and there interests himself in discovering the real situation. The result of this appears usually in requirements for admission, which are often adapted to some theoretical university position rather than to the possibilities of the modern American high school. In the debates upon these admission requirements a large faculty is apt to be divided, and the line of division usually separates those who know the schools from those who do not. If the latter be in the majority, the university is at once effectively handicapped. There is much talk of forcing schools to university standards, but this forcing is necessarily artificial and temporary if it runs counter to the inevitable tendencies which one who knows recognizes in the American school system. This system is more impregnable than the universities, for it is more extensive and better adapted to the peculiar conditions of American civilization. It is only a question of time when every university will recognize the fact that it must adapt itself to the possibilities of the schools, and that ancient or artificial standards can be maintained only so long as they approve themselves to the experience of the schoolmaster. The mountain will never come to Mahomet. To compel schools to differentiate early a small and select and expensive class for entrance to the universities is unfair both to school and to the university, and seriously checks the diffusion of higher education. To deny the privilege of breathing the university atmosphere to any product of a good secondary school involves such a narrow conception of education that one dislikes to associate it with the university. It has always seemed an anomaly that universities are inclined to rate themselves more upon the basis of their raw material than their finished product. A fine-meshed screen is set up at the beginning of the university career, when it would seem far more logical to set it up at the other end. This matter of entrance has much to do with the opportunity given to science to express itself in education. If its most promising and best trained material is turned back or handicapped when attempting to enter the university, a certain kind of educational theory may command the result, but it is a blockade against the general progress of education, in so far as it cuts off a great agency from operating upon the legitimate material.

A statement summarizing the claims set forth in this paper may be formulated as follows: The introduction of science among the subjects used in education has revolutionized the methods of teaching, and all subjects have felt the impulse of a new life; it has developed the scientific spirit, which prompts to investigation, which demands that belief shall rest upon a foundation of adequate demonstration, which recognizes that the sphere of influence surrounding facts may be speedily traversed and that everything beyond is as uncertain as if there were no facts; it has introduced a training peculiar to itself, in that it teaches the attitude of self-elimination, an attitude necessary in order to reach ultimate truth, and thus supplements and steadies the other half of life, which is to appreciate. To obtain these results, there must be teachers who can teach, whose background and source of supply is the investigator. Moreover, the results are immensely desirable, inasmuch as they do not interfere with anything that is fine and uplifting in the old education, but simply mean that the possibilities of high attainment and high usefulness are open to a far greater number.

JOHN M. COULTER.

THE ZEEMAN EFFECT.

EARLY in the year 1897 a paper was published in several journals by Dr. P. Zeeman, describing a series of experiments to determine the effect of magnetism upon the spectrum of a source of light placed in the magnetic field. The electromagnetic theory of light indicated in a general way that there would probably be some effect, and several investigators had already sought for it without success. The most noteworthy of these was Faraday, who made it the object of one of his last researches, and in this country Rowland made an examination with a Rutherford grating, before he had himself begun to rule the more perfect gratings of the present day. Zeeman himself had made an earlier unsuccessful attempt, and Fievez really observed what may have been the same phenomenon which Zeeman finally discovered, but he failed to understand its true character.

With the aid of a strong magnet and better spectroscopic apparatus than any of his predecessors had used, Zeeman attacked the problem the second time with success. He placed a Bunsen flame containing common salt between the poles of the electromagnet and focused the light on the slit of his spectrometer, arranging the flame so that the D-lines were sharply defined. As soon as the magnet was excited both lines widened out very much. By a careful series of subsidiary experiments he showed that the widening was due directly to the action of the field and was not a secondary effect such as might be caused by changes of density in the flame.

These results were communicated before publication to Professor Lorentz, who showed Dr. Zeeman that the widening could be predicted from Lorentz's theory that light is generated by the vibrations of electrically charged particles or ions; and that the same theory indicated that the edges of the widened lines should be plane-polarized or circularly-polarized according as the light falling upon the slit came from the source in a direction perpendicular or parallel to the lines of magnetic force, and that the amount of the widening would give the ratio of the charge to the mass of the luminous particles. Zeeman was able to verify fully the predictions as to polarization, and deduced from Lorentz's equations, as a rough value for the ratio e/m, the value 10^7.

The substance of the reasoning which led Lorentz to his conclusions is this: the motion of any ion can be resolved into a rectilinear component along the lines of force and two circular components in opposite senses in a plane normal to the same lines. These moving charges constitute currents, and consequently there are electromagnetic forces acting on the particles carrying the charges, owing to the presence of the magnetic field. The component along the lines of force is unaffected, while one of the circular components is accelerated and the other retarded by an equal amount. Hence we have present three distinct vibrations: one linear, along the lines of force, with the same period as the undisturbed motion; and two circular, in opposite senses, having periods, one a little longer and the other a little shorter than the original. Hence if the difference of periods introduced is sufficient to resolve the three lines in the spectrometer, and the light falling upon the slit comes from the source in a direction parallel to the lines of force, two lines instead of one will appear in the spectrum, one composed of right-handed and the other of left-handed polarized light; for the linear vibration can send no wave in its own direction. On the other hand, if the light proceeds directly across the lines of force to the slit, a triplet will be seen, consisting of a central component polarized in a plane normal to the lines of force and two lateral components polarized in a plane through the lines of force (bearing in mind that on the electromagnetic theory of light the direction of electric force is normal to the plane of polarization). But, if the difference of period is smaller, the lines of the doublet in the one case and of the triplet in the other, being streaks of finite width and not lines in the mathematical sense, will overlap, forming a single widened line whose edges alone show any definite polarization. Lorentz's mathematical treatment, which we will omit here, leads to the expression

$$\frac{\Delta\lambda}{\lambda^2} = \frac{e}{m} \cdot \frac{H}{2\pi V},$$

where λ is the wave-length of the original line, $\Delta\lambda$ is the difference in wave-length introduced between the extreme components of the triplet by the external magnetic force H, e is the charge on the moving ion, m its mass, and V the velocity of light.

It follows from this that if e/m is the same for all the luminous ions which give the spectrum of any one substance, the separation $\Delta\lambda$ is proportional to the square of the wave-length; but it became evident as soon as the experimental study was extended that no such general law could be laid down. For the same region in the spectrum of an element the separation may vary from apparently nothing up to an Angström unit or more for a moderately intense field.

The high value of e/m indicated by this phenomenon is significant. It is of about the same order as that found for the cathode ray particles and the ions caused by uranium and Röntgen rays and ultraviolet light; but the value for electrolytic ions is only about 400.

Zeeman's experiments were soon repeated by other investigators, including Lodge, Michelson, Preston and Cornu; and it was not long before magnetic fields were used of strength sufficient to fully resolve the several components. It then became known that the phenomenon was not nearly so simple as the first observations would indicate. Lodge* first noticed indications of a quadruplet in the case of the D-lines instead of a triplet, and later Preston† and Cornu‡ observed unmistakable quadruplets both in the case of D_1 and in the spectra of cadmium and magnesium. A little later Becquerel and Deslandres§ discovered in the iron spectrum a new type of triplet in which the states of polarization of the inner and outer components were interchanged. In February, 1898, Michelson published in the *Astrophysical Journal* a paper giving results obtained with the interferometer, some of which are not in accord with those obtained before and since then with the grating. Among other things he said that all lines are divided into what may provisionally be called triplets of approximately the same width, each member of a so-called 'triplet,' however, being itself complex, making the whole magnetic group formed from a single natural line quite complicated. As has already been stated, other investigators have found the degree of separation to vary quite strikingly even for neighboring lines, and although researches with the grating have discovered many complicated lines, the number of these is very small compared to those that appear as simple triplets. Professor Michelson maintains in defense of his methods that the resolving power of a grating is not sufficient to reveal the finer structure of the line as indicated by the interferometer. This last is no doubt true, but on the other hand the interferometer method is exceedingly indirect, and one hesitates before accepting conclusions drawn from an estimated visibility-curve as to the distribution of intensity in such a complicated source as he advocates. In any case, the assumption is involved that the source is symmetrical, and this certainly is not always true. An example is found in the cadmium group 4678, 4800, 5086, and the similar group in the spectrum of zinc. Each of these lines in the spark-spectrum shows a decided shading on the red side, which is retained by each component when they are separated by the magnetic field, making the whole group quite asymmetrical. It has also been shown* that many triplets and quadruplets are asymmetrical in separation. It is quite possible that such cases may account for some of Professor Michelson's results.

It cannot be denied, however, that, although most lines become simple triplets in the field, many are more complicated than the simple theory would indicate, many being fourfold and some at least sixfold, while some seem not to be affected by the field. Several theories have been de-

The Electrician, June 18, 1897.

†*Proc. Roy. Soc.*, vol. 63, p. 26.

‡*Comptes Rendus*, vol. 126, p. 181.

§*Comptes Rendus*, April, 4, 1898, p. 997.

*Zeeman, *Proc. Roy. Amst. Acad. Sci.*, Dec. 30, 1899. Reese, J. H. U. Circulars, June, 1899; June, 1900.

vised to account for these variations, which will be discussed later.

Some attempts to classify the spectral lines according to the character and extent of their magnetic separation have met with partial success. Preston* found that in the spectra of magnesium, cadmium and zinc corresponding lines of the homologous groups of three at the head of Kayser and Runge's second subordinate series act in exactly the same way in the magnetic field. That is, the most refrangible line in each group becomes a sharp triplet with the value 10 (relatively speaking) for the ratio $\lambda^2/\Delta\lambda$, the middle line a sextuplet with the value 11.5, and the least refrangible a rather diffuse triplet with the value 18.

A magnetic effect has been noticed on some of the air-lines,† but, with the possible exception of nitrogen peroxide, no effect has been observed on band-spectra, either by emission or absorption methods.

On the continent of Europe most of the work has been done with absorption spectra, particularly with that of the sodium flame; and in this field several most important discoveries have been made.

Egoroff and Géorgiewsky ‡ noticed that the light from a sodium flame in a magnetic field is partially polarized as a whole, *i. e.*, without being dispersed. Lorentz § showed that this phenomenon can be explained by absorption even when the field is uniform.

Righi || and Cotton ¶ have shown how the Zeeman effect may be demonstrated without a spectroscope by passing a plane-polarized beam of white light through a magnetized sodium flame or absorbing gas. By this method, which is very sensitive, nitrogen peroxide was shown to be subject to magnetic separation.

Macaluso and Corbino* discovered that a magnetized sodium plane rotates the plane of polarization to a very great extent for light whose wave-length is nearly that of one of the D-lines. Very close to the absorption-lines the rotation amounts to as much as 315 degrees. The immediate dependence of this phenomenon upon the Zeeman effect is shown in a very beautiful way in Cotton's little book 'Le Phénomene de Zeeman,' although I believe the more general principle that magnetic rotation of the plane of polarization is dependent upon the optical dispersion of the medium combined with a sort of generalized Zeeman effect, is due to Fitzgerald.†

An analogous effect of the magnetized flame upon light passed through it *across* the lines of force was discovered independently by Voigt ‡ and Cotton §. They found that the flame acts like a uniaxial crystal; that is, it introduces a phase-difference between waves polarized parallel and perpendicular to the lines of force. This phase-difference increases very rapidly as the wave-length approaches that of one of the D-lines. The explanation of this is also given in Cotton's book.

When we review the experimental facts concerning the effect of magnetism upon light we find many things inconsistent with the elementary theory first given by Lorentz. The equation which he obtained indicated that all spectral lines should become triplets under the influence of the field, and that the separation should vary as the square of the wave-length and as the strength of the field. On the contrary we find a considerable number of lines which

* *Phil. Mag.*, vol. 47, p. 165.

† Becquerel and Deslandres, *Comptes Rendus*, vol. 127, p. 18.

‡ *Comptes Rendus*, vol. 124, pp. 748, 949.

§ *Proc. Roy. Amst. Acad. Sci.*, vol. 6, p. 193.

|| *Comptus Rendus*, vol. 127, p. 216.

¶ *Comptus Rendus*, vol. 125, p. 865.

* *Comptus Rendus*, vol. 127, p. 548.

† *Proc. Roy. Soc.*, vol. 63, p. 31.

‡ *Wied. Annal.* No. 2, 1899, p. 345.

§ *Comptus Rendus*, vol. 128, p. 294.

become more complicated than triplets as well as some that are apparently unaffected; moreover the separation is very far from varying as the square of the wave-length, and recent work has shown that in some cases at least it is not proportional to the strength of the field.* In spite of these inconsistencies, however, we do not feel called upon to abandon the theory of electrified ions, for we must bear in mind that Lorentz's expression was deduced from assumptions which can hardly be realized in nature. He assumed a molecule of the simplest possible kind, consisting of a single positive or a negative ion acted upon by a central force proportional to its displacement and an electromagnetic force due to the external field equal in magnitude and direction to that which would act on a conductor carrying a current equal to the product of the velocity of the ion by the charge which it carries. Now it seems reasonable to suppose that the central force varies directly as the first power of the displacement because if it varied as any other power the period of vibration would change with the amplitude, and the spectral lines would change their position when the source of light became brighter, which has never been observed. The assumption that the same forces act on a particle carrying a charge e with a velocity v as would act on a conductor carrying a current of strength ev in the same direction is justified for comparatively low velocities by Rowland's experiment in Berlin in 1876. It seems utterly impossible, however, that a molecule should consist of a single ion, for in very few cases does the spectrum of an element contain less than twenty lines in the visible spectrum, and in the iron-spectrum there are thousands of them. A molecule which can vibrate in so many different periods must be exceedingly complicated. It is not surprising, then, that our simple theory is inadequate to account for the facts. Lorentz, in fact, knew this and instituted† a theoretical research on more general grounds before its insufficiency had been shown by the discovery of the quadruplet and other complications. He found that if the molecule naturally possessed more than three equivalent modes of vibration—that is, if it could vibrate in more than three ways with the same period—then the single spectral line corresponding to this period would become more than three-fold under the influence of magnetic force. Professor Lorentz does not regard this explanation as satisfactory, owing to the difficulty in conceiving a system having this property.

More recently Voigt† has proposed a theory which accounts for all the observed phenomena and is especially interesting in that by it he predicted cases of asymmetry found by Zeeman and others. Unfortunately the theory does not give any mechanical conception of the subject, merely consisting of the introduction into the equations of motion of terms of arbitrary form, which have no apparent justification.

It is comparatively easy to treat the case of a molecule composed of two ions carrying equal charges of opposite signs, and, in fact, Professor Rowland has lately given such a treatment before his students at Johns Hopkins University, but it leads to no new results as regards the Zeeman effect. Any case more general than this is very difficult.

HERBERT M. REESE.

* Shedd, *Phys. Rev.*, July, 1899, p. 1; Aug., 1899, p. 86. Reese, J. H. U. Circulars, June, 1900.

* *Wied. Annal.*, vol. 63, p. 278. *Astroph. Jour.*, vol. 9, p. 37.

† *Wied. Annalen*, No. 2, 1899, p. 345; No. 6, 1899, p. 352; No. 9, 1899, p. 290; No. 2, 1900, p. 376, and p. 389.

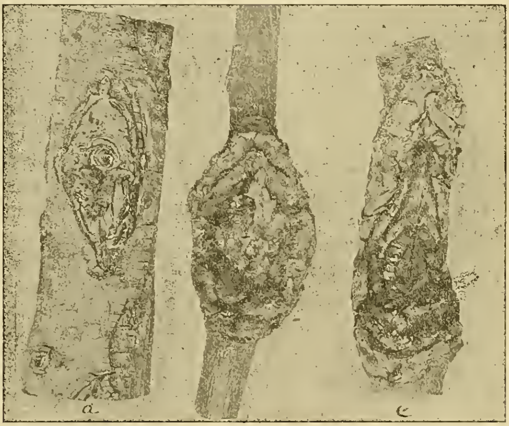
EUROPEAN APPLE TREE CANKER IN AMERICA.

SHORTLY after bulletin No. 163 of this station, entitled 'A New York Apple Tree

Canker,' was distributed, the writer received specimens of diseased apple limbs from various parts of the United States and Canada. Among the rest was a specimen from Nova Scotia which was noticeably different from any that I had yet seen. The injury was about six inches long on a limb two inches in diameter. Within the diseased area was a series of six ridges or convolutions in the wood surrounding a central starting point, each one of which evidently marked a year's growth of a parasitic fungus. The fungus, *Sphæropsis malorum* Peck., which has been shown to be the cause of the common New York apple tree canker, is more active in its growth. With this disease large areas of bark may be destroyed and the wood laid bare, or in other instances the bark may be much swollen and roughened, but the form of injury described above does not occur.

The appearance of the diseased limb, which was similar to that shown in Fig. 1 at *c*, strikingly resembled the work of *Nectria ditissima* as illustrated and described by European writers. However there was no fungus fruit in evidence, and as I was unsuccessful in obtaining more specimens the matter was dropped for a time.

In the latter part of May several specimens of diseased apple limbs were received from East Homer, Cortland County, N. Y., that were similar in appearance to the one from Nova Scotia, but in addition many portions of the dead bark and wood were thickly studded with the minute, deep red perithecia of a *Nectria*. Among the specimens were examples of recent infections as is shown at *a*, in the figure, as well as cankers of several years standing. The perithecia were abundant on all these specimens, so there seemed little doubt but that the *Nectria* was the cause of the diseased condition.



On visiting the locality it was found that the fungus was evidently confined to a small area and but few additional specimens were secured.

Through the kindness of Professor F. C. Sears, Wolfville, N. S., more specimens of the diseased apple limbs were obtained from that locality in June and the perithecia of the *Nectria* were found to be abundant on them. Professor Sears writes that this form of canker is doing serious damage in some of the orchards of the Annapolis Valley.

Specimens of the diseased branches were sent to Dr. R. Hartig, Munich, Germany, for identification, who writes that the cankers are caused by the fungus *Nectria ditissima.*

So far as I know this fungus has not as yet been recorded as occurring on apple trees in America, and its appearance in our orchards is of great practical importance since it is a serious pest to European fruit growers.

W. PADDOCK.

EXPERIMENT STATION, GENEVA, N. Y.

ZOOLOGY AT THE AMERICAN ASSOCIATION.

THE following papers were presented before Section F during the recent meeting at New York:

Sketch of the History of Statistical Inquiry of Evolution: By C. B. DAVENPORT, University of Chicago. The paper will appear in full in SCIENCE.

The Variation of Synapta: By C. L. EDWARDS, Trinity College. In the absence of the author this paper was read by title.

Variation among Hydromedusæ: By CHARLES W. HARGITT, Syracuse, N. Y. To be published in SCIENCE.

Variations in Jaws of Neries limbata: By MARIAN HEFFERAN, University of Chicago. Presented by C. B. DAVENPORT.

A quantitative study of variation made upon the species *Neries limbata*, collected at Cold Spring Harbor during the summer of 1899, gave the following results:

The character chosen for investigation was the number of teeth on the exsertile jaws. These number from 6–14 on each of the two jaws and were distinguished both for the sake of convenience and for purposes of comparison into definite teeth, those which occupy the distal half of the jaw and which are clearly separated from each other, and the indefinite teeth at the base of the jaw which are covered by a transparent horny layer.

The typical condition of the total number of teeth of 400 specimens of *Neries limbata* of Cold Spring Harbor is a curve of type I. or type IV., with a slight skewness in a negative direction from the mode 10. In case of the calculation of the right total teeth a transition from a curve of type IV. to an equally serviceable one of type I. could be made by dropping one extreme individual out of 400. The teeth on the right jaw appear to be slightly more variable than those on the left. The least variation is shown by the indefinite teeth. The degree of correlation between the two jaws is, on the whole, rather high, 0.820. Correlation is closer between the indefinite than between the definite teeth. A negative correlation exists between the definite and indefinite of the same jaw, that is, a small number of definite teeth is associated with a large number of indefinite and *vice versa.* An inverse relation also exists between the number of definite teeth and the age of the animal, older animals presenting fewer definite teeth.

This result as well as those of observation of many specimens showing many irregularities in the teeth, point to the conclusion that a process of erosion of the extreme teeth forms a large factor in the variation of the definite and perhaps indirectly of the indefinite teeth. A difference in the number of teeth in respect to the age of the animal has rarely been recognized in description heretofore and would be naturally overlooked unless a large number of specimens was examined. Little value can thus be placed upon the statements made in regard to the number of teeth in a large number of species where only a few specimens were found.

Some Cases of Saltatory Variation: By C. H. EIGENMANN and ULYSSES COX, Indiana University.

1. A specimen of *Rana pipiens* 54 mm. long has the forearm and hand of the right side duplicated. This arm is carried in a sling formed of a loop of the skin of the breast 4 mm. wide. This is a pathological abnormality rather than a variation that leads to the mutation of species.

2. A specimen of *Ameiurus natalis* 120 mm. differs from normal specimens in the total absence of all traces of the ventral fins. This is a saltatory variation which if prepotent might give rise to a race of catfish without ventrals, which would be considered generically different from the parent stock. This specimen is of interest in connection with the next case.

3. A variation of great importance and no small interest is presented by nine specimens of *Ameiurus melas*. These were collected at random from among a large number in Mitchell's Cave, Kentucky. Each one possesses one or more supplemental nasal barbels. These might give rise to the supposition that they are the direct result of the cave life, but an examination of all the data makes it probable that we are dealing with a coincidence of a cave habitat and a prepotent saltatory variation that appears adaptive to a cave existence. The conclusions arrived at concerning these specimens are: (1) the variation is saltatory. (2) it is bilateral without reaching perfect bilateral correlation; (3) it is improbable that the variation arose independently in each of the specimens; (4) the variation probably arose in one of the ancestors of the specimens; (5) admitting (4) the saltatory variation arising in an ancestor was prepotent to a very high degree.

Variation and Correlation in the Tibial Spines of Melanoplus: By C. B. DAVENPORT, University of Chicago.

This paper, embracing work done in connection with Miss Ora H. Hubbard gives the constants and their probable errors of the distributions of frequencies of the spines of the inner and outer rows of spines on the right and left-hand tibiæ of *Melanoplus femur-rubrum* from Newport, Rhode Island. The correlations of the number of spines in the various rows was determined quantitatively and the interesting result obtained that there is a greater correlation between rows symmetrically placed with reference to the plane of symmetry of the whole animal than there is between rows so placed with reference to the plane of symmetry of the single leg. Finally the range of individual variation is greater than the range of variation of the modes of various species of the genus *Melanoplus;* consequently in the individual variation of the one species there is provided material for the various typical numbers of spines found in all species of the genus.

Variation in Io: By C. A. Adams. To be published in full.

On the Origin and Distribution of Leptinotarca decem-lineata Say, and the part that some of the Climatic Factors have played in their Dissemination: By W. L. TOWER, University of Chicago. To be published in SCIENCE.

A New Eyeless Isopod Crustacean from Mexico: By A. S. PACKARD, Brown University.

Some years ago I received through the kindness of Professor A. L. Herrera, of the City of Mexico, an isopod crustacean taken from a well at Monterey, Mexico. It appears to be a true *Conilera*, and may be named *Conilera stygia*.

It is totally eyeless, and adds another to the blind fauna of our caves and wells. Hitherto the genus has been represented by but a single species, inhabiting the British coasts. Compared with Bates and West-wood's figure of *C. cylindracea*, the body is longer, the antennæ much longer, reaching to the middle of the first thoracic segment, those of the second pair nearly to the middle of the seventh thoracic segment. Only the first three pairs of legs are short, with a very thick hand; the four hinder pairs of legs are long, slender. The two last divisions of the pleopods are unequal, the outer division very narrow, but a little more than half as long as the broad inner division or endopodite. Length of body 25 mm.; breadth 5 mm.

This form is like most if not all other blind or eyeless arthropods in having a longer body, antennæ, and legs in compensation for the loss of eyes.

A Contribution to the Fauna of the Caves of Texas: By C. H. Eigenmann, Indiana University.

In the early part of September, 1899, I visited San Marcos, Texas, to secure if possible some living specimens of the cave Salamander occasionally thrown out of the Artesian well of the United States Fish Commission. This well taps an underground stream about 190 feet from the surface. No specimens of the Salamander *Typhlomolge* came to the surface during my stay, but I received two living specimens from Superintendent J. L. Leary.

Besides the Salamander three species of Crustaceans had been secured from this well. These were described preliminarily by Mr. Benedict, *Proc. U. S. Nat. Mus.*, Vol. XVIII. One of these, *Palæmonetes antrorum*, is very abundant and many are thrown out from the well each day. The eyes of this species are degenerate far beyond those of the blind *Cambarus pelucidus* of the Mississippi valley caves. They will be described elsewhere. The second one *Ciralonides texensis* is not nearly so abundant as the first. During my stay of three days I secured several specimens. It can readily be seen in the receiving basin of the well when thrown out.

The third *Crangonyx flagellatus* is much rarer and no specimen was secured during my stay. Instead however a single specimen of a related species (*Crangonyx bowersii*) was secured.

These are all the species that can readily be seen with the naked eye, when swimming about the receiving basin. A screen of bolting cloth (No. 2) placed over the outlet for a short time secured a number of additional species, viz, the front half of a new species of *Cæsidotea*, two new species of *Copepoda*, a *Cypridopsis* and a Crustacean that defied identification and was later lost, as well as a flat worm. The evidence from the screening is that there is yet a rich subterranean fauna to be obtained from this well.

There is near the well a spring arising evidently from the same source by the side of which the well is insignificant in its yield of water. No blind creatures have been recorded from this spring, and the difficulty in straining its output is much greater than that of straining the well. Through the liberal policy of the Honorable G. M. Bowers and Dr. Hugh M. Smith, of the United States Fish Commission, a plankton net is now in use at the San Marcos well, and we may expect other additions to the fauna of the well and the underground stream it taps.

Near San Marcos are two small caves. Ezell's cave was formerly open to the public and provided with steps and other facilities for entrance. The opening leads into a pit about forty feet deep, with one side, that nearest the entrance, quite perpendicular, but with some projecting rocks. At the bottom of this pit and at the side furthest from the entrance a smaller opening led downward to the water, which was said to be about one hundred feet from the entrance. The Texas variety of small boy has found amusement in rolling rocks down the entrance thus smashing the steps and closing the former opening at the bottom of the first series of steps. It was necessary to take a side branch to reach the water. This side branch, for sufficient reasons, I did not take to its end, although my assistants managed to get through to the water without, however, securing any specimens. I was amply rewarded for not entering the deeper recesses by finding in the twilight of the entrance pit an abundant cave fauna.

Not far from this cave is Beaver cave. This is a winding, twisting channel of no great height or width. All the available time was devoted to securing specimens and the cave was not followed to the end. There is no water except in a pit dug in the cave.

Animals, though few in species, were surprisingly numerous in both these caves. The following species were secured in the well and caves:

1. A flat worm sp.?—Artesian well.

Mollusca.

2. *Helicina orbiculata* Say. — Ezell's Cave.
3. *Vitrea petrophila*, Bland, pale var. — Ezell's Cave.
4. *Bifidaria contracta* Say. — Ezell's Cave.
5. *Heticodiscus Eigenmanni* Pilsbry, n. sp. — Ezell's Cave.

Crustacea.

6. *Cypridopsis vidna obesa* Brady and Robertson. — Artesian well.
7. *Cyclops cavernarum* n. sp. — Artesian well.
8. *Cyclops Learii* n sp. — Artesian well.
9. *Cæcidotæa smithii* n. sp. — Artesian well.
10. *Ciralonides texensis* Benedict. — Artesian well.
11. *Brackenridgia cavernarum* n. sp. and genus. — Ezell's Cave. Beaver Cave.
12. *Crangonyx Bowersii* n. sp. — Artesian well.
13. *Palæmonetes antrorum* Benedict. — Artesian well.
14. *Larval crustacean*, unidentified.

Myriopoda.

15. sp.?—Ezell's Cave. Beaver Cave.

Arachnida.

16. *Theiridium Eigenmanni* Banks n. sp. — Ezell's Cave. Beaver Cave.

Thysanura.

17. *Degeeria cavernarum* Pack. — Ezell's Cave. Beaver Cave.
18. *Nicoletia texensis* n. sp. — Ezell's Cave. Beaver Cave.

Orthoptera.

19. *Ceutophilus palmeri* Scudder. — Ezell's Cave. Beaver Cave.

Diptera.

20. *Larval Chironomus.*—Artesian well.

Vertebrata.

21. *Typhlomolge rathbuni* Stejneger.—Artesian well.

Convergent Evolutions as illustrated by the Blind Lizard Rhineura: By C. H. Eigenmann, Indiana University.

Living specimens of the blind lizard *Rhineura* show a great similarity in color, shape and method of progression to earthworms which they also resemble in habits. Living specimens were exhibited.

The Development of the Eyes in the Blind-fish Amblyopsis: By C. H. Eigenmann, Indiana University.

The eye is perfectly normally outlined. A lens is normally developed but does not become located within the iris. It degenerates early, disappearing before the fish exceeds 10 mm. in length. The optic nerve is normally developed, and retains its connection with the eye and brain till maturity. It gradually becomes attenuated, and in the old a connection between the eye and brain cannot be traced. The vitreous body does not become developed to any extent. The secondary optic cup at all times remains a shallow depression. An outer reticular layer does not develop and cones are uncertain in their development.

The Eye of the Cave Salamander Typhlotriton: By C. H. Eigenmann, Indiana University.

The eyelids are closing over the eyes. The eye is normally developed. The retina is normal in the young but with the metamorphosis or shortly thereafter the rods and cones disappear.

Some of the Internal Changes which accompany Ecdysis in Insects: By W. L. Tower, University of Chicago.

The most important of the changes which precede ecdysis in insects is the development of the exuvial glands. These are unicellular hypodermal glands, usually pear-shaped, with the smaller end prolonged into a tube which opens through a pore beneath the cuticula. Sometime before ecdysis these glands begin to grow larger, and the nuclei have well developed membranes with clearly defined chromatin skeins. In the few days immediately preceding ecdysis the glands enlarge rapidly, owing to the secretion of an albuminous fluid within the cells, and the nuclei become amœboid, sometimes branching in fine dendritic processes among the globules of the exuvial fluid. The time for ecdysis having arrived the glands pour out their contents gradually until there is a thin layer of the exuvial fluid separating the old cuticula from the hypodermis. The hypodermis now rapidly secretes a new layer of cuticula, and thus the whole animal is covered with this fluid, which enables it to crawl out of its old shell with ease.

These exuvial glands occur on all parts of the body, but are most numerous on the pronotum. After ecdysis they become small and rounded, with densely staining nuclei.

The point of interest now is the secretion of the secondary layer of the cuticula, which forms the real strength of the insect's skeleton. During ecdysis and for a short time thereafter the only cuticula is an extremely thin layer which is easily bent or torn, but about thirty minutes later the deposit on the secondary layer begins and continues until near the middle of the instar. This layer is often ten times the thickness of the primary cuticula, and seems to be like a cellulose layer, giving in some cases a 'cellulose test.'

Sugar and Muscle Fatigue: By Frederic S. Lee, College of Physicians and Surgeons, New York.

The origin of muscular energy, whether from nitrogenous or non-nitrogenous substance, has been disputed. There has likewise been much discussion over the respective parts played by the two recognized causes of muscle fatigue, namely, the destruction of substance necessary for contraction and the poisoning of the muscle by so-called fatigue products. Recent experimental evidence both for and against the idea that sugar is an important source of bodily energy has been brought forward by others. The author, together with Mr. C. C. Harrold, has studied the problem by experiments on cats which had been put under the influence of the peculiar drug, phlorhizin. It is known that this drug removes the carbohydrates from the body. Fasting animals were put under the influence of the drug, were then killed, and the contractile power of the muscles, which continues normally for several hours after death was then tested. The muscles of well-phlorhizinized animals were found to have a contractile power much less than normal, and in this respect resembled muscles in a pronounced state of fatigue. That this result was due to the removal of carbohydrate from the muscles rather than to a mysterious specific action of the drug on the muscle protoplasm is rendered probable by the fact that if dextrose be given to an animal that is well under the influence of phlorhizin the fatiguing effect of the drug is counteracted and the contractile power of the muscles is restored. It seems to be a legitimate conclusion that normally sugar is a source of muscle energy and the destruction of it a cause of muscle fatigue.

The supposed connection between the oncoming of rigor mortis and the loss of carbohydrate is confirmed by these experiments. A well phlorhizinized animal may begin to go into rigor within five minutes after death, and the rigor is often complete within a half hour.

The Structure of the Poison Glands of Schilbeodes gyrinus: By Hugh Daniel Reed, Cornell University.

The poison gland is supposed to be in the axil of the pectoral fins. It is in reality just beneath the epidermis and almost entirely surrounds the spine. Both dorsal and pectoral spines have poison glands. The gland tissue is composed of large, coarsely-granular, doubly-nucleated cells. Each poison cell is surrounded by a layer of spindle-shaped epithelial cells. The clavate cells of the skin are identical in structure with the poison cells. They are wanting in those places which are entirely covered or protected by other organs. From their resemblance in structure to the poison cells and their distribution, it is probable that their function is one of protection. The poison cells are regenerated from the cells of the epidermis.

Before the poison can be effectual the cell membranes must be destroyed, for there is no duct leading from the gland to the exterior. The spine is entirely covered by epidermis which has to be punctured.

Development and Relations between the Intestinal Folds and Villi of Vertebrates: By W. A. Hilton, Cornell University.

Folds, villi and valvolæ conniventes are convolutions of the mucosa alone, other foldings involving the muscular coats not being considered. Folds and villi are homologous, villi being more specialized and occurring usually in otherwise highly specialized vertebrates. Several influences upon size and form of villi are easily recognized, such as the influence of food and size of the animal. By phylogenetic and ontogenetic study of a number of species it is found that there are at least two ways in which the villi are formed from folds. The more usual way being like that which takes place with the chick, that is, straight folds becoming more and more wavy until very zigzag folds are produced and villi formed from these by separations which take place at the tip of the fold angles downward.

Villi are present in the large intestines of most mammals sometime before birth, and occur also in the appendix vermiformis of man before birth, possibly showing the appendix of man to be an atrophied part of the cœcum.

Hystolysis of Muscle in the transforming Toad (Bufo lentiginosus): By Louise Katz, Ithaca, N. Y.

It is shown in this paper that while the outward changes in transformation are exceedingly rapid, taking place in about three days, the internal changes are in process for a considerably longer period. The first sign of muscle change is a myotome near the base of the tail opposite the growing legs. Here a few fibers, often but a single one, occur on each side. Later, when the legs are about three-quarters grown, degenerating fibers are scattered all along the tail, but are most numerous at the tip.

Forms of degeneration; there are four quite well-marked types:

1. Mass degeneration, in which the whole fiber degenerates in one or more large masses.

2. Degeneration with transverse bands of degenerating substance, alternating with bands of normal muscle.

3. Breaking of the fibrillæ into smaller fragments, the so-called sarcolytes.

4. Transformation into transverse bands with intermediate gaps as if liquefaction had taken place.

In all the types the changes appear to be intrinsic in the muscle itself; homogeneous material is produced, reacting characteristically with the various stains and fixers, and disappearing by liquifaction *in situ.* Thus far I have found no evidence of fragmentation of the nuclei, nor marked increase in protoplasm as described by various investigators. In many fibers, however, showing no other signs of degeneration, the nuclei were no longer evenly distributed, but collected in a longitudinal row near one end. Fat occurs as a late product of degeneration. There is no evidence that phagocytes play any part in the degeneration process occurring in the muscle.

The Biogenetic Law from the Standpoint of Paleontology: By JAMES PERRIN SMITH, Stanford University, California.

This paper was a general discussion of the repetition of ancestral characters in the ontogeny of the individual; difficulties of interpreting and correlating stages of growth of the individual with ancestral genera with illustrations taken from the life history of fossil invertebrates and an exhibition of ontogenic series of fossil ammonites, and a discussion of the meaning of the stages of growth.

Reconsideration of the Evidence for a Commom cinosaur-avian stem in the Permian: By HENRY F. OSBORN, American Museum of Natural History, New York City.

This paper will be printed in the *American Naturalist*, August, 1900.

Relation of Dinosaurs to birds as discussed since 1864.

History of opinion.

Theory of descent from a common stem form, Huxley.

Descent from Iguanodontia, Baur.

Gradual reaction of opinion to the view expressed by Fürbringer in '88, that Dinosaurs and birds have descended from a common reptilian ancestor.

Review of all the osteological resemblances between birds and Dinosaurs. Grounds for a reconsideration of the problem.

(*a*) The clawed quadrupedal ancestry of birds.

(*b*) Structure of the Permian Proganosauria.

(*c*) Origin of the bipedal type.

(*d*) Probability that birds and Dinosaurs sprang from a common bipedal type in the Permian period constituting dinosaur-avian stem.

The Reptilian Origin of Mammals as illustrated in the Structure of the Occipital Condyles: By HENRY F. OSBORN, American Museum of Natural History, New York City.

Huxley's theory of the amphibian origin of mammals recently revised by Hubrecht and Kingsley.

Difficulties in the theory.

Theory of derivation of mammals from the *Anomodontia.*

Tripartite structure of the condyles in these reptiles.

Essential tripartite structure of the condyles in certain mammals.

Mammal condyle of amphibian and not of reptilian origin.

Structure, Relationship and Habits of the Eocene Creodont, Patriofelis: By HENRY F. OSBORN, American Museum of Natural History, New York City.

This paper will be printed in *Bulletin* of the American Museum Natural History.

Discovery of a complete skeleton of Patriofelis, Seeley by the American Museum Expedition.

Full description of this skeleton by Dr. J. L. Wortman with theory of aquatic habits of the life and of the probable relationship of the aquatic carnivora.

Re-study of the skeleton.

(*a*) Skull and dentition of feline type.

(*b*) Feet transitional between raccoon and feline type.

(*c*) Probable terrestrial habits of this type.

(*d*) Insufficient ground for theory of relationship of the *Pinnipedia.*

Phylogeny of the Rhinoceroses of Europe: By Henry F. Osborn, American Museum Natural History, New York City.

This paper will be printed in the *Bulletin* of the American Museum of Natural History.

Difficulties in a systematic arrangement of Rhinoceroses resulting from recent discoveries.

Necessity of phylogenetic classification.

Great antiquity of separate phyla.

Our ignorance of the stem form.

Revision of the family Rhinocerotidæ into seven subfamilies representing different phyla.

Theory of migration from Africa.

On the Inflection of the Angle of the Jaw in the Marsupialia and other Mammals: By B. Arthur Bensley, Columbia University, New York City. To be printed in Science.

On a Phylogeny of the Marsupialia: By B. Arthur Bensley, Columbia University, New York City. (Abstract withdrawn.)

On the Composition of the Monotreme Skull: By B. Arthur Bensley, Columbia University, New York City. (By title.)

Lymphosporidium truttæ, nov. gen. nov. sp. The Cause of a Recent Epidemic among Brook Trout: By Gary N. Calkins, Columbia University, New York City.

In October, 1899, my attention was called to a disastrous epidemic among the brook trout (*Salvelinus fontinalis*) in a Long Island Hatchery. Investigation showed the cause of the trouble to be a new genus which I have placed provisionally with the *Serumsporidia* (L. Pfeffer) among the Sporozoa, a class of parasitic Protozoa.

The spores of the parasites accumulate in the lymph spaces of the fish and prevent normal nourishment of the tissues. This leads ultimately to ulcers of various shapes and sizes.

The spores give rise to 8 sporozoites or germs each of which develop into an adult amœboid individual about 25 mu. (.001 inch) in length. This penetrates the bundles of unstriped muscle cells of the digestive tract and becomes mature. At maturity a spore-forming cyst is developed in the lymph and the spores are carried throughout the entire animal.

The epidemic which lasted from May until December, 1899, killed off all the fish in the hatchery. The origin, preventive measures and remedies were not discovered.

The Primitive and Secondary Types of Vertebrate Embryos: By Professor Charles S. Minot, Harvard Medical School, Boston, Mass.

This paper gives a comparison of the development in marsipo-branchs, ganoids, dipnoans and amphibians as representing the primitive type of vertebrate development. The Selachian, Teleost, Sauropsidan and mammalian types are regarded as secondary modifications. It also includes a comparative study of the form of the embryo in the Ichthyopside and Amniota.

A Partial Phylogeny of the Genus Cancer. By A. S. Packard, Brown University.

A comparison of the miocene tertiary species of cancer (*Cancer Proavitus* Pack.) with the two species now living in the waters of Vineyard Sound, brings out the interesting fact that the extinct species is the stem or ancestral form from which the recent species have apparently descended.

Cancer Proavitus presents characters in which it resembles *C. borealis* as well as *C. irroratus*. It resembles *C. borealis* in the higher, more pointed granulations on the postero-lateral margin of the carapace, and in the quite high and sharp spines on the ridges of the hand as well as the numerous setiferous spines and hairs; on the other hand it is similar to *C. irroratus* in the shape of the nine teeth on the antero-lateral margin of the carapace, and in the straight postero-lateral margin of the same. It is rounder, narrower, the carapace more convex, and the body in general more hairy than either of the existing species.

It thus seems most probable that the miocene species, being a more generalized, composite form, is the ancestor from which, either toward the end of the pliocene or the beginning of the quaternary period, the two living species sprang. *C. irroratus* has inherited the exact shape of the lateral teeth and the shape of the postero-lateral margin of *C. proavitus*, while *C. borealis* has retained the higher spine-like granulations or submuricate feature of the carapace and hand and the hairiness of the body.

On the whole the evidence that our two northeastern species have descended from a much more rounded, convex, and hairy miocene form living in the same geographical area seems to be well established.

It would be most interesting to compare this fossil species with very young individuals of our living species, but after inquiry I find that they are not in existence in our museums. It is to be hoped that specimens of the very young may be collected and compared with the fossil species. It is known that in cancer the body grows wider with age.

A Review of the Problem of Sex Cells in the Hydromedusæ: By Charles W. Hargitt, Syracuse University.

A former paper before this section (*Proc. A. A. A. S.*, 1889) set forth the view that for *Eudendrium ramosum* the ova originate in the endoderm. This was not passed without controversy. As a preliminary contribution it was not emphasized at that time. After some years the problem was again taken up in connection with related problems and four species of *Eudendridæ* examined, namely, *E. ramosum*, *E. racemosum*, *E. dispar*, and *E. tenue*.

As a result it may be said that while in *E. ramosum* and *E. tenue* the ova arise strictly in the endoderm, and never at any time find their way into the ectoderm, in the species *racemosum* and *dispar* these products are found abundantly in both tissues. However, it must not be overlooked that in every case the primitive ova are found in the endoderm, and only during the process of growth do they migrate into the ectoderm. In view of these facts it would seem to be a just inference that their origin is endodermal, though in these two species they may migrate into the ectoderm and complete development in that position.

Any glance at the literature will show a a strange confusion as to data. Weismann himself has contributed to this, due in part to confusion arising in methods of work, done in part upon optical sections rather than actual. Similar errors have doubtless been due to similar methods by earlier as well as later observers.

However, it seems that in Hydromedusæ there is a great variation in this matter. For whether the hydroid or medusa be the more primitive, or likewise as to the more primitive character of hydro- or scyphomedusa, there must have been a time when there was a transition from the one to the other. If therefore such transitions have arisen phylogenetically, is it not possible that among the more plastic genera such transition may continue at the present time?

In any case it would seem to be extremely rash to predicate any such character as a diagnostic and distinctive difference between the sub-classes Hydromedusæ and Scyhhomedusæ.

The Mosaic of the Single and Twin Cones in the Retina of Micropterus salmoides: By George D. Shafer, Indiana University.

In the *American Naturalist* for February, 1900, Eigenmann and Shafer described the different patterns of twin and single cones found by them in the retina of several different species of fishes. No attempt was made by them to determine the modification of any of the patterns in different parts of the same eye of any species.

The present paper deals with the modification of the pattern in the large-mouthed black bass, *Micropterus salmoides*. The questions more particularly dealt with are:

I. Is the pattern of the twin and single cones the same over the entire retina?

II. What relation does the direction of the rows of cones which go to make up the pattern bear to the surface of the eye?

III. What is the difference between the number and size of the elements in the young and old fish?

Several series of tangential sections were cut from a band passing from the anterior edge of the cornea around the back of the eye to the posterior edge of the cornea; other series were secured from a band passing from the upper edge around the lower edge of the cornea.

I. The variation of the pattern.

The general variation in the twin and single cones in this species is that of Eigenmann and Shafer's pattern D. In this pattern the twin cones are so arranged that if the lines joining the centers of the components of a twin (*i. e.*, the axes) were continued they would form a square; a single cone is placed in the center of this square. The division lines separating the components of the twin cones thus point toward the single cone. That is, the division lines form right angles with the sides of the square. This ideal pattern for this species is most nearly approached over the anterior and posterior surfaces of the eye. As we go from the anterior and posterior edges of the cornea toward the wider parts of the eye, the pattern changes from a square to a rhombus. Its area at the same time increases until we approach the back of the eye itself, where the patterns are again smaller and closer together; even crowded.

Immediately at the upper and lower edges of the cornea the division lines separating the two parts of the twin cones instead of pointing toward the single cones are turned until they point almost directly toward each other. At these points, the square has varied to a rhombus of which the two obtuse angles are almost one hundred and eighty degrees. The single cone remains in the center of this modification of the square. As we go from the upper and lower edges of the cornea toward the back of the eye, the rhombus is quickly changed into a square again. In other words the double cones soon have their division lines turned again in the direction of the single cones. Except very near the cornea, the patterns in the band from the upper to the lower edges of the cornea are much more crowded than in other parts of the eye.

II. The relation of the pattern to the eye. A study of the modification of the pattern as described in the first section shows that such a modification is brought about on the surface of the eye if the axes of the twin cones lie on two series of circles. The center of one of these series of parallel circles lies approximately at the upper edge of the iris, the center of the other approximately at the lower edge. These two series of circles cut each other at right angles near the anterior and posterior edges of the iris and cut each other at more and more acute angles at the top and bottom of the iris. The extreme modification that would be brought about by the close adherence of the twins on these lines is relieved by the interpolations of additional double rows of single and twin cones.

III. The patterns in the young and old fish. A comparison of the eye of a young fish 60 mm. long which measured 3.8 mm. from cornea to optic nerve and 4.7 mm. longitudinally with the eye of a fish 335 mm. long measuring 10 and 13 mm. respectively along the lines measured in the smaller specimen shows (1) that no new elements are added during the growth of the eye; (2) the distance between the elements increases about in proportion to the increase in the surface of the eye. The ratio between the surfaces of the smaller and larger eye is about 1:0.144, the average ratio between the distance from center to center of two elements of the pattern in the small and large eye is 1:0.164; (3) on the average the ratio between the size of the elements in the small eye and large eye is 1:2.

CONCLUSIONS.

I. The pattern varies in shape from a square on the anterior and posterior edges of the eye to a rhombus on all other parts of the eye except where rows of cones have been interpolated; and it is largest at the middle of the anterior and posterior faces of the eye.

II. The cones are arranged in rows which correspond to circles formed on the surface of the eye by two sets of parallel planes. One set of these planes is perpendicular to an axis passing from the upper edge of cornea through the center of the eye to the back and the other set of planes is perpendicular to an axis passing in a similar manner from the lower edge of the cornea.

III. As the surface of the eye increases in size toward old age the area of the patterns increases in about the same proportion. No new elements are added.

Development of the Lungs in the Frogs, Rana Catesbiana, R. silvatica, and R. virescens: By MARGUERITE HEMPSTEAD, Meadville, Pa.

The principal features of the development of the lungs in the American frogs studied may be stated as follows:

1. The formation of the respiratory apparatus is similar to that in the toad, but differs from the latter in having the communication with the pharynx formed very early in larval life instead of at the end as in the toad.

2. The respiratory apparatus arises as a solid downgrowth from a solid portion of the pharynx, which is unlike the formation of the lungs in Bombinator as described by Goette, and unlike the description of the process in other European forms in all the accounts available for reference.

3. The lung rudiment is single and solid, and not a pair of hollow evaginations as described by Marshall.

Development of the Lungs in the Common Toad Bufo lentiginosus and in the Tree Toads (Hyla pickeringii and Hyla versicolor): By SIMON HENRY GAGE, Cornell University.

With the tree toads the pharynx becomes hollow before the external gills are absorbed, and the lungs become hollow and open into the pharynx before the external gills disappear.

In *Bufo* the lungs and pharynx very early become hollow, but the larynx remains solid and has no communication with the pharynx until the tail is almost wholly absorbed and the young toad is almost completely transformed. The connection of the lungs with the pharynx seems to be one of the last acts of metamorphosis. When the larynx opens into the pharynx it is lined with ciliated epithelium, apparently the epithelium is non-ciliated before the opening is established.

In the ciliation of the oral cavity and the pharynx of the toad (*Bufo*) the columnar ciliated epithelium spreads from the œsophagus into the pharynx and the mouth.

The Chronological Distribution of the Elasmobranchs: By O. P. HAY, American Museum Nat. History, New York City.

There is first presented a diagram which shows, by means of curves, the number of species of fossil elasmobranchs which are known to have existed during each of the geological periods.

There is also presented a table which contains lists of the genera of Elasmobranchs which occur in each of the geological periods.

The portion of geological time occupied by each of the families is discussed.

Some conclusions are drawn bearing on classification of the Elasmobranchs.

The Lower Temperature Limits of Incubation for the Egg of the Common Fowl: By CHARLES LINCOLN EDWARDS, Trinity College.

Since the time of the Egyptians it has been known that warmth is the chief factor in incubation of eggs of birds. Modern investigators have established 35 degrees C. to 39 degrees C. as the normal temperature range. Rauber ('84) gave as the optimum 38 degrees and minimum 25 degrees. It is well known that cold, if not too intense or too prolonged, will slow development.

Dareste gives 28 degrees C. as the physiological zero for the hen's egg, below which, of course, there is no development.

Kaestner produced anomalies by interrupting the normal development through cooling the egg.

Warynski showed that yolk rises because of change in specific gravity and sticks to the vitelline membrane, thus producing arrest of development and consequent monsters.

Féré ('94) established the ratio of development at abnormal temperature to the stage at normal of 38 degrees, as follows:

Temperature:	34°	35°	36°	37°	38°	39°	40°	41°
Index of development:	0.65	0.80	0.72	?	1.00	1.06	1.25	1.51

In my experiments a Cyphers incubator together with a calibrated thermometer divided to one-fifths of a degree was used.

Incubation 1. In 12 eggs incubated at 30.75 degrees C. for 7 days, 19 hours, chicks reached an average of about one-half the normal development. Over half of this clutch of eggs developed hydropic vesicles in the blastoderm. These arise from enlarged blood islands in the mesoderm, in which the primitive corpuscles degenerate and the space becomes filled with lymph.

Incubation 2. In 6 eggs incubated at 29¼ degrees C. for 5 days, 18 hours, the ontogenetic stage was from the 16- to the 24-hour chick. The cephalic end of the neural groove was trifid in one variate. Lateral branches of primitive groove were developed posteriorly.

Incubation 3. In 12 eggs incubated at 28¼ degrees C. for 7 days the ontogenetic stage was from a central area of undifferentiated mesoderm to 27 hours.

Incubation 4. In 10 eggs incubated at 27 degrees C. for 6 days, with the exception of one uncertain anomaly, the greatest development was represented by a primitive streak 1.8 mm. long. Blastoderms vary from 4.5 mm. to 8 mm. in diameter.

Incubation 5. In 9 eggs incubated at 26 degrees C. for 7 days, 19 hours, showed a primitive streak 1.3 mm. long as the greatest development with the exception of one case with open neural folds 1 mm. long. Blastoderms vary from 4 mm. to 7 mm. long.

Incubation 6. In 8 eggs incubated at 25.5 degrees C. for 6 days there was a variation from no development to a primitive streak and groove 1.7 mm. long. Blastoderms vary from 5 mm. to 5.5 mm. in diameter.

Incubation 7. 11 eggs at 25.5 degrees C. for 7 days, 2 hours, 8 developed from a central area of mesoderm cells to a primitive streak 2 mm. long. Of the other three one showed open neural folds and rudimentary brain, one 22 mesodermic somites and one was a 3-day chick. The last three may have been previously incubated. Blastoderms vary from 4 to 11 mm. in diameter.

Incubation 8. Nine eggs at 24.5 degrees C. for 6 days, $1\frac{1}{2}$ hours gave one primitive streak 1.5 mm. long as the greatest development. Blastoderms vary from 4 mm. to 1 cm. in diameter.

Incubation 9. 11 eggs at 24 C. for 6 days, 19 hours. Blastoderms vary from 5.4 mm. to 7 mm. in diameter. With the exception of a degenerated 2-days chick only 4 of the 11 blastoderms showed a trace of the primitive streak.

The Fishes of Africa as Exponents of former Geographical Conditions: By THEODORE GILL, Smithsonian Institution.

The fishes of Africa represent two very different elements. One is composed of Asiatic types; the other of South American types. The latter indicate a former connection direct or mediate with South America; the latter are in conformity with the present association of the continents.

The Moringuid Eels and their Geographical Distribution: By THEODORE GILL and HUGH M. SMITH, Washington, D. C.

The Moringuid eels are remarkable for their very elongate body disproportionally elongated abdominal cavity, and remoteness of the heart from the branchial apparatus. The family had been supposed to be peculiar to the oriental seas, but a recent discovery has directed the attention of the authors to the American eels generally and it was recognized that 3 genera previously associated with Murænesocidae really belong to the Moriuguidæ. *Stilbiscus* indeed is a synonym of the type genus, *Moringua*. A new species of the related genus *Apthalmichthys* has also been added to the American fauna.

The History of the Word Mammalia: By THEODORE GILL, Smithsonian Institution.

The word mammalia was first introduced by Linnæus, in 1758, as the expression of a concept first appreciated by him. It was formed in analogy with animal. Simple as the explanation is it has never been recognized.

C. H. EIGENMANN,
Secretary.

SCIENTIFIC BOOKS.

An Introduction to the Study of the Comparative Anatomy of Animals. By GILBERT C. BOURNE. Vol. I. London, George Bell & Sons; [New York, Macmillan]. 1900. 16mo. Pp. xvi + 269. Price, $1.10.

It is rather difficult to form an adequate estimate of a work from its first volume. It is not easy to get the author's perspective; and then there are so many things left in doubt which the remainder of the series may straighten out. The plan of Mr. Bourne's work is peculiar. It starts out with a general chapter which deals with fundamental morphological and physiological principles, and then takes up the frog, treating first of its anatomy and then of its histology. This last subject leads up to a consideration of the cell, and this is followed by a consideration of the early history of the frog. The remainder of the book is occupied by detailed accounts of several Protozoa, Hydra and Obelia. We are promised that the second volume will deal with the Cœlomate Metazoa.

A rather careful examination shows few errors, yet there are several points on which the student will need fuller information than the volume affords. Thus terms are used without explanation or definition, while here and there comparisons are made which will not be intelligible because the student has no information as to one of the subjects of comparison. While finding fault it might be well to ask why it is that many English writers persist in the use of the terms epiblast, mesoblast, and hypoblast. It is not easy to see how the work can be used in courses of comparative anatomy as usually given in America, except as a reference book for occasional use. Its wealth of detail concerning forms usually studied in the laboratory would be seized upon by many students as affording answers to the questions which they are asked and are expected to obtain from the animals themselves.

On the other hand, it contains much information which is of value to the student and which the beginner might fail to find out for himself. The discussions of individuality, alternation of generations, and sexuality are especially good.

The book is well printed and its fifty-three illustrations are well chosen and clear.

J. S. Kingsley.

PROFESSOR MOSSO'S LECTURES AT THE CLARK UNIVERSITY DECENNIAL.

Two lectures were delivered by Professor Angelo Mosso at Clark University during its Decennial Celebration, in the summer of 1899, which seem to deserve wider publication than they will obtain through the volume issued and distributed by the university in commemoration of that event. This volume has been already reviewed in Science, without, however, special reference to the contents of these addresses.

The former of the lectures, of which notes are here presented, is called 'Psychic Processes and Muscular Exercise.' It would be difficult to exaggerate the importance of the ideas presented, although the campaign against present public opinion which a practical realization of some of its consequences would demand might well discourage a Pestalozzi. The logical conclusion has, however, been arrived at both by the psychologist and by the medical man, as well as by the physiologist, who is both.

One of the most important of the rising beliefs of American medical men regarding common school education is corroborated in this address by the eminent Italian. In it he sought to show "how intimately related are mental processes and movements. If we desired to make a pedagogical application," he says, "we might say that physical education and gymnastics serve not only for the development of the muscles, but for that of the brain as well."

Children should begin reading and writing only after they are nine years old, and it is becoming evident that as much time should be devoted to muscular exercise as to intellectual exercise. No absolute local separation of movement and sensibility is demonstrable. Muscular fatigue exhibits phenomena identical with intellectual fatigue. Internal reflex phenomena seem largely to condition attention which, therefore, is not wholly within the will's control. Nerve cells have only a small power of resistance and show, on the average, every ten seconds a tendency to rest. It is probable that only part of the brain is active at a time—the various parts relieve each other. The structure of all nerve cells seems to be the same—it is only their relations which are different. The more mobile any animal's extremities the more intelligent, other things being equal, he is: the most mobile parts are those which are the most sensitive.

The other address, called by Professor Mosso 'The Mechanism of the Emotions,' adds not a little to our knowledge of the somatic aspect of emotion, dealing especially with the sensitivity of the bladder—one of the most sensitive of the viscera.

The seat of the emotions of joy and of sorrow seems to Professor Mosso to lie undoubtedly in the so-called sympathetic nervous system. In 1881 he noticed (with Dr. Pellacari) the contraction of the bladder during weak sensations. Besides those of the bladder, he has studied the movements of the stomach and intestines, including the rectum.

The bladder's movements are both active and passive, but the former are of chiefer interest and alone are considered here. The experiments were conducted both on dogs and on women. The instrument employed was his own plethysmograph, a very valuable hydraulic arrangement too well known to need description here. This was connected with the bladder by means of a 'female catheter.' The human subjects studied were young women in the hospitals, who, of course, volunteered their services. He recorded in the cases of both the women and the dogs the thoracic and abdominal respiration and the movements of the bladder independently. He considers that the bladder exhibits 'the most delicate reflex movements which occur in the organism.' The bladder contracted not only to very slight emotional stimuli, but also to changes in the organism instigated by problems in mental arithmetic.

In explanation, it is postulated that the blood pressure increases and the blood vessels and smooth muscular fibers contract in order to prevent the blood from collecting in the abdominal cavity, the brain requiring additional blood pressure for its additional activity—regulated by the sympathetic nervous system.

Mosso is right in denying in this lecture teleology to the reflex phenomena of strong emotions, but he is wrong in statements as to Darwin's theory, for this the latter never claimed for strong affective states. It is the excitement, and not the mode, of the emotion (pleasant or unpleasant) which, in case of the bladder, determines the loss of organic equilibrium. This is a conclusion easy to accept when we consider that one of the functions of the visceral blood vessels is to be a reservoir for blood necessarily expelled from other bodily parts.

GEORGE V. N. DEARBORN.

TUFTS COLLEGE MEDICAL SCHOOL.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Comparative Neurology, May, 1900. The first article, 'Observations on Sensory Nerve Fibers in Visceral Nerves, and on their Modes of terminating,' by Dr. G. Carl Huber, details observations made upon the innervation of the hollow viscera by means of methylene blue iutra-vitam. This is followed by a short note by the same author on 'Sensory Nerve Terminations in the Tendons of the Extrinsic Eye-muscles of the Cat,' the organs being somewhat different from the ordinary neuro-tendinous spindles found in the other skeletal muscles. Dr. Huber and Mrs. Lydia M. DeWitt follow with a paper of 50 pages and six plates entitled 'A Contribution on the Nerve Terminations in Neuro-tendinous End-organs,' describing the structure of these sense organs as studied by the methylene-blue method in amphibians, reptiles, birds and mammals. In all cases the tendons are supplied with a special nerve end-organ consisting of several tendon fasciculi, embryonic in nature, which in birds and mammals are generally surrounded by a connective tissue capsule, while they are usually not so surrounded in reptilia, and never in amphibia. They are generally, but not always, innervated by a single non-medullated nerve fiber, which, after repeated branching, ends in one or many tufts of non-medullated fibers, the details of whose structure vary with the different animals studied. Dr. H. H. Goddard describes and figures a new brain microtome recently made at Clark University for cutting entire human brains. F. J. Cole, of University College, Liverpool, gives a prospectus of 'A Proposed Neurological Bibliography of the Ichthyopsida.' 'The Number and Size of the Nerve Fibers Innervating the Skin and Muscles of the Thigh in the Frog,' by Elizabeth Hopkins Dunn, M.D., demonstrates that the fibers innervating the thigh are more numerous and of greater average caliber than those innervating the rest of the leg. Hence in the frog the fibers of greater diameter run the shorter course. About 8 per cent. of the fibers which innervate the thigh divide, one division running on into the lower leg. Dr. H. Heath Bawden gives 'A Digest and a Criticism of the Data upon which is based the Theory of the Amœboid Movements of the Neurone,' accompanied by a bibliography of 115 titles. The usual book notices complete the number.

THE July number (Vol. I., No. 3) of the *Transactions of the American Mathematical Society* contains the following articles: 'Wave propagation over non-uniform conductors,' by M. I. Pupin, of New York, N. Y.; 'Ueber Systeme von Differentialgleichungen denen vierfach periodische Functionen Genüge leisten,' by M. Krause, of Dresden, Germany; 'On linear criteria for the determination of the radius of convergence of a power series,' by E. B. Van Vleck, of Middletown, Conn.; 'On the existence of the Green's function for the most general simply connected plane region,' by W. F. Osgood, of Cambridge, Mass.; ''D' lines on quadrics,' by A. Pell, of Vermillion, So. Dak.; 'Sundry metric theorems concerning n lines in a plane,' by F. H. Loud, of Haverford, Pa.; 'An application of group theory to hydrodynamics,' by E. J. Wilczynski, of Berkeley, Cal.; 'Determination of an abstract simple group of order $2^7.3^6.5.7$ holoedrically isomorphic with a certain orthogonal group and with a certain hyperabelian group,' by L. E. Dickson, of Austin, Tex.

Dr. John Guiteras, who resigned the chair of pathology in the University of Pennsylvania to fill a similar position in the University of Havana, has established there a journal entitled *Revista de Medicina Tropical.*

DISCUSSION AND CORRESPONDENCE.

THREE FORGOTTEN NAMES FOR BIRDS.

In *Museum Leskeanum Regnum animale quod ordine systematico disposuit atque descripsit*, D. L. Gustavus Karsten, Vol. I., Leipzig, are proposed three names for birds which appear to have been overlooked by ornithologists, at least since 1817. The names are *Certhia longicauda*, *Trochilus maximus*, and *Pipra tricolor*, all of Karsten. Viellot (*Nouveau Dictionnaire d'Histoire Naturelle*, * * * Nouv. ed., T. VII. (1817), p. 364) refers to *Trochilus maximus* giving the proper reference to Karsten's work, but curiously enough gives Latham as the authority for the species.

While these names have not been noted in recent works it seems they do not affect any now in use in ornithologic nomenclature. This statement is made on the authority of Mr. Witmer Stone of this Academy.

From a bibliographic standpoint it would be interesting to know whether the *Museum Leskeanum Regnum Animale* (1798) consists of one or two volumes. Most bibliographers, to whom I have referred, say two volumes ; but Cuvier (*Le Regne Animal*, nouv. ed., T. III. (1830) gives but one volume. In the library of the Academy of Natural Sciences of Philadelphia there is volume I. only of the work, which is divided into six classes, viz, Mammalia, Aves, Amphibia, Pisces, Insecta, Vermes, the latter including the invertebrates except the insects, from which it will appear evident that nothing remains of Animalia to be treated in another volume. The first 44 pages (classes I.–IV.) of the work are numbered in Roman, and parts V. and VI. are numbered independently, and are in Arabic (pp. 1–320). To this difference in pagination may be due the statement that the work is in two volumes. Or the fact that Classes V., Insecta (pp. 1–136), was published in advance in 1788 with a separate title-page may account for the other volume.

William J. Fox.
Academy of Natural Sciences, Philadelphia.

NOTES ON INORGANIC CHEMISTRY.

There has been a question frequently discussed as to the delicacy of spectroscopic reactions as compared with the sense of smell. Kirchhoff and Bunsen were able by the spectroscope to detect $1/14 \times 10^{-6}$ mg. of sodium ; on the other hand, E. Fischer and Penzoldt could recognize the odor of $1/460 \times 10^{-6}$ mg. of mercaptan. It was clear, however, that the figures of Bunsen by no means represented the limit, and Professor F. Emich of the Technische Hochschule of Graz has lately devoted some time to the study of the problem. His results are published in the *Sitzungsberichte* of the Academy of Science of Vienna. His method is to use Geissler tubes with exceedingly fine capillary portion ; these are filled with hydrogen under greatly diminished pressure. A slit at right angles to the capillary allows the light from a limited portion of substance to pass, the weight of which is easily calculated. The lowest pressure at which the line H is visible was observed and from this the calculation made. The results obtained in three observations were 1×10^{-12} mg., 7×10^{-14} mg. and 3×10^{-13} mg. It thus appears that, on the average, the quantity of hydrogen recognizable by the spectroscope is ten thousand times less than that of mercaptan by the sense of smell. Emich calls attention to the fact that if, as Hutton affirms, the ordinary hydrogen spectrum is visible only when the gas contains a trace of oxygen, the quantity of oxygen thus detected by the spectroscope becomes far more minute than the figures given for hydrogen.

The subject of the radio-active substances in pitchblende continues to excite the interest of chemists, and much work is being done by the two Curies, Giesel, Debierne, Becquerel, von Lengyel and others. The last number of the *Chemical News* contains a paper by Béla von Lengyel of Budapest, describing his efforts to prepare a radio-active barium synthetically. His process is to fuse together uranyl nitrate with two or three per cent. of barium nitrate, and then fuse the oxides obtained in the electric arc. The fused mass is dissolved in nitric acid, much of the barium nitrate crystallized out, and the remainder of the barium precipitated as the sulfate. The sulfate thus obtained is found to be radio-active, and from it the chlorid and the carbonate, both also radio-active, have been obtained. Early in his paper von Lengyel says: "It is obviously clear that the question of radium being a chemical element must be answered in the negative as soon as it is found possible to transform ordinary inactive barium into the radio-active variety." In closing he says that his researches "do not nearly suffice to decide the question as to whether radium is an existing chemical element or not, but these facts render doubtful the existence of radium."

FOLLOWING this work comes that of Becquerel, described in the last *Comptes Rendus*, in which similar experiments are repeated from a different standpoint. Uranium chlorid is mixed with barium chlorid, the barium precipitated by sulfuric acid. The barium sulfate thus obtained is more or less radio-active, but the radio-activity of the uranium salt left has diminished correspondingly. These experiments show the futility of trying to determine in this manner, whether the radio-activity resides in the uranium, or is due to an independent substance which is an impurity in the uranium.

J. L. H.

THE UNIVERSITY OF BIRMINGHAM.

THE report of the Executive Committee of the Governors of the University of Birmingham, dated May 31, 1900, relative to the recent development of the work in applied science and engineering and the use of the recent gifts of Mr. Carnegie and others has been printed for distribution to friends of the university and its extended work.

On May 12, 1899, the endowment fund collected by a canvassing committee amounted to £143,000. Mr. Carnegie, through Mr. Joseph Chamberlain, offered to contribute £50,000 for a special science department when a total of £250,000 should be pledged. This condition was fulfilled within a week. On February 28, 1900, the sum had become £326,500, and at the date of the report it was £327,468.

Mr. Carnegie requested Mr. Chamberlain to send a deputation to the United States which should 'report on its return what more is necessary, to give Birmingham a first-class modern scientific college, modeled, as I have said, after Cornell'—intending, presumably, a union of literary with scientific and professional work, as is usual in American State universities, and with a well-developed 'practical' side—'not necessarily big, but perfect of its kind.' Professors Burstall, Renwick and Poynting were accordingly sent. They visited several of the principal eastern colleges of the United States and Canada. They conclude:

"We desire to express our admiration alike for the high ideal of scientific education which is the aim in American universities and for the enthusiasm in all classes which renders it possible to approach so near that ideal. Everywhere we found that the wealthier classes realize the importance of university education and encourage the universities by generous gifts and everywhere, both by teachers and by students, these gifts are being used for higher learning and research."

They "believe that the system of engineering education existing at Cornell and other institutions we have visited and the system of Mining and Metallurgy at Boston and Montreal, all with their four year courses, are admirably planned and carried out." They advise their adoption including laboratories and workshops for instruction which they found "thoroughly practical and on such scale that the knowledge acquired there by the student would be of use in his subsequent professional life."

The proposed scale of salaries is very modest —£750 for professors, £300 to £400 for assistant professors, £150 for 'demonstrators' in science and instructors in shops, and £100 and £70, respectively for minor appointments. The investment of £155,000 is proposed in buildings and equipments for the new Technical College, and anticipates an annual operative expenditure something over £10,000 with a faculty of eighteen in all grades and presumably for a student body of about 200 in all classes. A 'commercial faculty' is proposed, consisting of three officers and involving an expense of £6000 in equipment and £2200 annually in maintenance.

A four-year's course is planned, in which the differentiation between the mechanical and electrical engineers will occur at the end of the third year and between these and the civil engineers somewhat earlier. Mathematics and pure science and the modern languages will be given in the University proper. A good general education is expected to be secured in advance of entrance into the technical courses, which are made entirely professional, as is usual in law and medicine.

R. H. Thurston.

THE PREVENTION OF HAIL STORMS.

Mr. John C. Covert, U. S. Consul at Lyons, writes to the Department of State: An effort is being made in this section of France to dissipate hail storms by firing cannon at the clouds. Fifty-two cannon, manned by 104 cannoneers and their chiefs, have been distributed over an area of 2500 acres of rich vine land. For the expense of the experiment, the Government appropriated 2000 francs ($386), the departmental council 1500 francs ($289), the National French Agricultural Society and a number of wealthy wine growers added 12,000 francs ($2316) and furnished fourteen more cannon. The Minister of War supplied powder for $2\frac{3}{4}$ cents per pound.

A high point in the vine land to be covered by the experiments was selected as the central post of observation and a signal code adopted. When a shot is heard from the central post all the cannon are fired, at first twice per minute; more slowly after the first ten shots. I translate the report of the first firing at the storm clouds this season:

The farmers of Denicé were aroused at 1.30 o'clock on the night of June 5th–6th. The storm was very severe. The artillerists, from 40 to 50 strong, fired their guns and stopped the thunder and lightning. In the neighboring communes, the people saw columns of flames rise 300 feet above the cannon when the shots were fired. At several places, women recharged the cartridges.

The wine growers are organizing to attack the hail storms in many of the great wine-growing regions of France. The two experiments thus far reported are pronounced successful. A writer in one of the wine-grower's organs says:

The results obtained from these experiments are such that organizations will be established at once in all the places that have heretofore been ravaged by hail.

I am told that the practice of shooting at the clouds was known in France over a hundred years ago, and that it originated in Italy. It is to be more extensively carried on this year than ever before.

BRITISH CONGRESS ON TUBERCULOSIS.*

It has already been announced in the *British Medical Journal* that a Congress on Tuberculosis is to be held in London next year. The date of meeting has been fixed for the last week of April. H. R. H. The Prince of Wales, is the President of the Congress, and among the Vice-Presidents are the Duke of Fife, the Marquis of Dufferin, K.P., Earl Spencer, K.G., Lord James of Hereford, Lord George Hamilton, P.C., Lord Reay, G.C.S.I., Lord Lister, P.R.S., Sir John Burdon Sanderson, Sir Hermann Weber, the Presidents of the Royal Colleges of Physicians and Surgeons, the President of the Royal College of Veterinary Surgeons, the Director-General of the Medical Department of the Navy and the Chairman of the London County Council. The President of the Organizing Committee is the Earl of Derby; the Chairman, Sir William Broadbent; the Honorary Treasurers, Lord Avebury and Sir James Blyth; the Chairman of the General Purposes Committee, Professor Clifford Allbutt, and the Honorary Secretary-General, Mr. Malcolm Morris. The Prince of Wales has consented to open the Congress in person. In order to make the Congress as comprehensive as possible every colony and dependency in the Empire will be asked to send representatives, and distinguished guests will be invited from Europe, Asia and America. Authorities in these and other countries will be invited to take an active part in the work of the Congress.

It is hoped that the Congress will be able to adopt practical resolutions which will serve to indicate the measures best adapted for the suppression of tuberculosis. The work of the Congress will be divided into Sections, as follows: Section 1 (State and Municipal). Presi-

* From the *British Medical Journal*.

dent—Right Hon. Sir Herbert Maxwell, Bart, M.P. Secretaries—Dr. Bulstrode, Dr. Arthur Newsholme, Dr. James Niven. Section 2 (Pathological, including Bacteriology). President—Professor Sims Woodhead, M.D. Secretaries—Dr. Wethered, Professor Rubert Boyce, Dr. E. J. McWeeney. Section 3 (Tuberculosis in Animals). President—Sir George Brown, C.B. Secretaries—Professor Hobday, Royal Veterinary College; Messrs. Harold Sessions, F.R.C.S., Stuart Stockman (Glasgow), Frank Leigh (Bristol). Section 4 (Clinical and Therapeutical, including Climatology and Sanatoria). President—Sir R. Douglass Powell, Bart, M.D. Secretaries—Sir Hugh Beevor, Bart, M.D., Dr. Hector Mackenzie, Dr. R. W. Philip, Dr. William Calwell (Belfast). The subscription for ordinary members will be £1. As the expense of the Congress will be very considerable, donations to the Reception Fund are invited. Donations of more than one guinea will be considered as including members subscription, and will entitle the donor, whether an individual or a corporation, to all the privileges of membership.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR JAMES EDWARD KEELER, the eminent astronomer, director of the Lick Observatory, died at San Francisco on August 12th, from the effects of heart disease. He was born in La Salle, Ill., on September 8, 1857.

PROFESSOR RUDOLPH VIRCHOW has been elected an honorary member of the Vienna Academy of Sciences, and Dr. Ernst Abbe, professor of meteorology and astronomy at Jena, Dr. Karl v. Zittel, professor of paleontology and geology at Munich, and Dr. Felix Klein, professor of mathematics at Göttingen, have been elected correspouding members of the same Academy.

MR. OVERTON W. PRICE, of the Division of Forestry of the U. S. Department of Agriculture, has been promoted to the position of superintendent of working-plans and assistant chief, vacant by the appointment of Mr. Henry S. Graves to the professorship of forestry in Yale University.

IN response to a recent requisition from the Bureau of American Ethnology for an assistant ethnologist especially competent to deal with the Siouan languages, the Civil Service Commission held, on July 24th, a competitive examination for the position. Only a single candidate entered the competition—Mr. John R. Swanton, of Massachusetts, a recent student in Columbia University, where he took a special course in American linguistics under Dr. Boas; he passed the examination most satisfactorily. His immediate field of work will include reservations of the Dakota and other Siouan Indians.

THE Rolleston Prize, Oxford University, has been awarded to Gustav Mann, B.Sc., New College, for his published 'Research on the Histology of Vaccinia' and for his unpublished 'Atlas of the Anatomy of the Brain of the Frog.'

PROFESSOR WILLIAM C. STUBBS, director of the Audubon experiment station in Louisiana, has gone to Hawaii as a representative of the Agricultural Department to make a study of the sugar industry on the islands and to establish a Government experiment station there.

DR. HIDEZO IKEDA of Tokio has been sent to America by the Japanese Government to study the agriculture of this country, with special reference to tobacco and cotton.

WE noted recently a movement for a memorial to the late Sir William Flower. We now learn from *Nature* that it is proposed that the memorial shall consist of a bust and a commemorative brass tablet to be placed in the Whale Room of the Natural History Museum —one of the departments in which he was most interested, and to which he devoted special care and attention. Subscriptions (which must not exceed two guineas) should be paid to Dr. P. L. Sclater, treasurer of the Flower Memorial Fund, 3 Hanover Square, W.

DR. RUDOLPH HESSEL, who had charge of the propagating ponds of the U. S. Fish Commission, died at Washington on August 16th from the effects of sunstroke. He was born in Baden 75 years ago, and became connected with the U. S. Fish Commission in 1877.

PROFESSOR CHARLES SCOTT VENABLE, professor emeritus of mathematics at the University of Virginia, died at his home in Charlottesville, Va., on Aug. 11th. He was born in Prince

Edward County, Va., on April 19, 1827. He held professorships in the universities of South Carolina and Georgia and in Hampden-Sidney College. During the Civil War he was a lieutenant-colonel and aid-de-camp on the staff of General Robert E. Lee. In 1865 he was appointed professor of mathematics in the University of Virginia, and became emeritus professor five years ago.

Dr. Erich Nymann, a Sweedish naturalist from Upsala, has died at Munich on his return from a three year's expedition to the Malay Archipelago and New Guinea.

A field party from the Botanical Department of the University of Chicago is making an ecological study of North Manitou Island, in the northern part of Lake Michigan. They will be at work during August and September.

Mr. James Mooney, of the Bureau of American Ethnology, has recently gone to the old Cherokee country in North Carolina for the purpose of completing his studies of the traditions, games, and medical practice of the Cherokee Indians. He has an extended memoir on the creation myths and traditions of the tribe in the Nineteenth Report of the Bureau, which is now well advanced in the press; and he has, in more or less advanced preparation, two or three additional memoirs on the tribe, one or more of which he plans to complete by aid of information to be obtained during the autumn.

Professor C. E. Beecher, of Yale University, is conducting an expedition to the Grand Canyon of the Colorado and Arizona.

It is reported that Dr. Riggs, of the Field Columbian Museum, has discovered a nearly perfect skeleton of a dinosaur on the banks of Gunnison River, Colorado.

The American Chemical Society will hold its next general meeting in Chicago during Christmas week. A committee has been appointed to arrange for the celebration of the 25th anniversary of the foundation of the Society which will occur on April 6, 1901.

The British Medical Association will hold its next annual meeting at Cheltenham under the presidency of Dr. G. B. Ferguson.

The members registered at the International Medical Congress numbered 6170, nationalities being represented as follows: France, 2293; Russia, 805; Germany, 572; the United States, 412; Italy, 324; Great Britain, 222; Spain, 219; Belgium, 147; Austria, 141; Argentine Republic, 108; Switzerland, 101.

At the Paris Electrical Congress, reports will be presented as follows: 'Dynamo Electric Machinery,' Professor S. P. Thompson; 'Units,' M. Hospitalier; 'Photometry,' M. Violle; 'Asynchronous Generators and Compounding of Alternators,' M. Leblanc; 'Rotary and Rectifying Converters,' M. P. Janet; 'Use of Condensers,' M. P. Boucherot; 'Tramway Current Supply,' M. Postel-Vinay; 'Electric Lamps,' M. Blondel; 'Electro-chemistry,' M. Bouilhet; 'Calcium Carbide Furnaces,' Gen. Sebert; 'Wireless Telegraphy,' M. Blondel and Capt. Ferrié.

A civil service examination will be held sometime during September or October to fill the position of chemist in the U. S. Geological Survey at $1400 per year. Candidates will be examined in theoretical and physical, inorganic, organic and analytical chemistry, assaying, elementary mineralogy and scientific French and German. The duties of the position involve especially assaying and other branches of analysis relating to geological work. The positions of physicist and assistant physicist in the U. S. Geological Survey, at $1800 and $600 respectively, are likewise to be filled upon examination. The date of this examination has been postponed from August 21 to September 20.

A prospective publication of the Bureau of American Ethnology is the extensive dictionary of the Natick (Indian) language of Massachusetts, compiled by the late James Hammond Trumbull, and for some time preserved in the original manuscript by the American Antiquarian Society, at Worcester. The vocabulary is of much interest and value as one of the two most extensive records of the language of the aborigines of New England—the other being the well known Eliot Indian Bible. It will form the initial number of a new series of bulletins to be issued by the bureau in a superior style of publication; the size, paper and binding correspond with those of the annual reports. The authority for this new series of publications was granted during the last session of Congress at the instance of Honorable Ernest W. Roberts, of Massachusetts, for the purpose of affording suitable means of printing and distributing the large collections of rare technical ethnologic matter now in the archives of the bureau or within its reach—of which the Trumbull vocabulary is a typical example. The greater part of this vocabulary, which will include an introduction by Dr. Edward Everett Hale, is already in type.

Herr Carl Marhold, of Halle, announces a book by Professor Schenk under the title 'Aus meinem Universitätsleben.' It is a reply to the professors of the University at Vienna, whose memorial to the Austrian Government led to his dismissal from the university.

Mr. James G. Cannon, who has been engaged in the reorganization of the business of Messrs. D. Appleton & Company, has issued a statement to the effect that the plans have been perfected, and, though the Company will remain for the present in the hands of the receiver, all authors' accounts will be paid in full. This will naturally be of interest to scientific men, as Messrs. D. Appleton & Company publish a long list of scientific books. The relations of an author to a publisher who is unable to carry out his contracts is a somewhat perplexing question. Messrs. Harpers Brothers have sold certain of their publications without the consent of the authors, and it seems doubtful whether they have a legal right to do this. There should probably be in America, as there is in England, a society of authors which could give advice, and, if necessary, take legal proceedings. Perhaps a committee of the American Association for the Advancement of Science could perform this function for scientific men.

A decision has been rendered by the British House of Lords which somewhat concerns scientific teachers and lecturers, and has probably never been before the Courts in the United States. Certain speeches of Lord Roseberry's were reported verbatim in the London *Times* and these were republished without the permission of the proprietors of the newspaper in question. Suit was brought to restrain the publication, and this was granted in the first Court. The decision was reversed in the Court of Appeal, but has now been re-affirmed by the highest court. This court holds that the verbatim reporter of a speech is the 'author' in the meaning of the copyright act. Perhaps the lectures given to a class of students or a paper read before a scientific society are not made public. But if so, according to this decision, they could be reported and published by anyone, and the report copyrighted, so that not even the author himself could use it.

Nature states that the Botanical Museum of Florence has recently received a donation of considerable interest in connection with the history of botany in Italy, viz, the collections made by Micheli, by Bruno Tozzi, and by G. Targioni-Tozzetti in the 18th century, including the type-specimens of species named by these and other eminent botanists. The donation includes also Micheli's and Targioni-Tozzetti's collections of seaweeds.

The Commercial Cable Company's new cable from the Azores to New York, via Novia Scotia, has been successfully laid by the cable steamers *Faraday* and *Silvertown* and is now completed and in working order. This line, which forms the Commercial Company's fourth Atlantic cable, connects at the Azores with the system of the Europe and Azores Telegraph Company and was opened for business on August 1st.

The 'Two-Penny Tube,' as the Central Electric Underground System of London has been named, as constructed and equipped by American contractors, is making a great impression with its bright, porcelain-lined, electric-lighted, cleanly stations, brightly illuminated carriages and smooth and rapid service. The indications are that suburban transportation in Great Britain and on the Continent will be revolutionized by American methods.

We take from *Nature* the following items: Mr. Leonard S. Loat, who is investigating the fishes of Egypt for the British Museum and the Egyptian Government, was last heard of at Korti, where he reports (on May 18th) a hot wind and a temperature of 115° in the shade. He had sent home upwards of 2200 specimens of Nile-fishes to the Natural History Museum, and as soon as the river had risen sufficiently would proceed to Senaar and Khartoum. Mr. J. S. Budgett, who is engaged in collecting fishes on the River Gambia, dates his last letters (June 22d) McCarthy's Island in the interior. There had been a disturbance in the colony, and one of the Commissioners and a party of police were believed to have lost their lives; but this had not affected Mr. Budgett's operations, and he had a large number of Polypteri and Protopteri in floating cages in the river. He was in good health, and expected to be home in September.

At the recent annual meeting of the Victoria Institute, the address, 'On our Coal Reserves at the Close of the Nineteenth Century,' was given by Professor Edward Hall, F.R.S. The author had selected this subject for the annual address, because public attention had recently been directed to the question of coal reserves, owing chiefly to the increased price of coal and to the unprecedented output of this mineral from British mines, amounting in 1899 to 220,085,000 tons, being about 18,000,000 tons over that of the previous year. Referring to the Royal Coal Commission of 1866, presided over by the late Duke of Argyll, the author stated that the production had doubled since the Report of that Commission was issued in 1870 —a result scarcely anticipated by the Commissioners—and the public were inquiring 'for how long a period our coal reserves would be able to bear the increasing drain.' The author advocated the imposition of an export duty on coal shipped to Continental states, which were taking from us about 40,000,000 tons annually, so as to form a fund towards the relief of increasing taxation, and he concluded by the proposal for a new Commission on coal resources, showing the subjects which would require investigation.

UNIVERSITY AND EDUCATIONAL NEWS.

Three scholarships in music have been endowed in Yale University by Mr. Morris F. Steinert. Mr. Steinert has already endowed four scholarships in music at this institution, and has given it an important collection of musical instruments.

A gift of £1000 has been received by the University of London from the children of the late Mr. William Lindley, in remembrance of their father.

The following additions have been made to the faculty of the engineering departments of the Iowa State College at Ames, Iowa: H. J. Burt (University of Illinois), assistant professor of civil engineering; Dr. Samphear (Cornell University), assistant professor of electrical engineering; L. J. Young (State College, Pa.), instructor in mining engineering, and I. A. Williams (Iowa State College and University of Ohio), instructor in ceramics.

The Montana School of Mines, at Butte, will begin its college year on the second Tuesday of September. A serious lack of funds has delayed the successful opening of the school for some time, but it is now hoped that the institution can open and offer the courses of study which its organizers have carefully arranged. The present faculty includes Nathan R. Leonard, acting president, and professor of mathematics, recently of the State University of Iowa; William King, professor of chemistry and metallurgy, a graduate of the Western Reserve University, and for sixteen years instructor in chemistry in the Case School of Applied Sciences in Cleveland and for two years in the College of Montana at Deer Lodge; and Dr. Chas. H. Bowman, professor of mechanics and mining engineering.

Dr. W. D. Scott, Ph.D. (Leipzig), has been appointed to a newly created instructorship in psychology and pedagogy in Northwestern University.

Dr. Nagel, docent in physiology in the University at Freiburg, i. B., has been promoted to an assistant professorship, and Dr. Ernst Weinschenk to an assistant professorship of petrography in the University of Munich.

Dr. Karl Boehm has qualified as docent in mathematics in the University of Heidelberg, and Dr. P. Rabe as docent in chemistry in the University at Jena.

Dr. Le Dantec, professor in the medical faculty of Bordeaux, has been appointed to give a course of instruction in tropical diseases. In Holland the teaching of tropical medicine has recently been inaugurated by Dr. J. H. Kohlbrugge, docent in the University of Utrecht.

SCIENCE

FRIDAY, AUGUST 31, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

DOCTORATES CONFERRED BY AMERICAN UNIVERSITIES.

REPORTS received from official sources show that during the past year the degree of doctor of philosophy has been conferred by 22 universities on 233 candidates. The numbers given by each university in the humanities and in the sciences and a comparison with the two preceding years are shown in the following table:

	Humanities.	Sciences.	Total for 1900.	1899.	1898.
Chicago	18	19	37	24	36
Harvard	21	15	36	24	26
Johns Hopkins	13	20	33	38	33
Yale	16	10	26	30	34
Columbia	9	12	21	33	22
Cornell	8	11	19	7	19
Clark	0	9	9	5	12
Pennsylvania	3	6	9	20	24
New York	7	0	7	9	5
Columbian	2	3	5	0	1
Michigan	4	1	5	4	7
Wisconsin	4	1	5	7	5
Brown	3	0	3	3	1
Minnesota	2	1	3	2	1
Princeton	2	1	3	3	0
Vanderbilt	2	1	3	0	0
California	1	1	2	3	1
Stanford	2	0	2	0	2
Virginia	2	0	2	2	0
Bryn Mawr	0	1	1	3	3
Nebraska	0	1	1	1	2
Tulane	1	0	1	0	0
Colorado	0	0	0	1	0
Kansas	0	0	0	1	0
Missouri	0	0	0	1	0
Syracuse	0	0	0	1	0
Washington	0	0	0	2	0
Total	120	113	233	224	234

The table shows that the degree was conferred nine times more often than last year, but once less often than in 1898. For the three consecutive years beginning with 1898, the degree has been conferred in the sciences 105, 115 and 113 times; in the humanities 129, 109 and 120 times. Students are consequently pretty equally divided between the two divisions as here drawn. The separation is, of course, somewhat arbitrary. Psychology, sociology and education have been placed with the sciences, while philosophy and political economy are included under the humanities. Yet a student of philosophy may have interests falling strictly under the sciences—in the sense of the natural and exact sciences in which this word must for convenience be used—while a student of education may have but few such interests.

The degrees were in all cases the Ph.D., with the exception of one D.Sc. from Harvard. The University of Chicago conferred the degree of Ph.D. on nine students in the divinity school. These have not been included above as it is not certain that the work has been equivalent to that of the other candidates. The same holds, however, for some of the degrees in education and in chemistry in which cases perhaps a technical or professional degree should be given.

The University of Pennsylvania has during the year decided to require the printing of the doctors theses, and steps in this direction have been taken at Harvard. The degree seems not to have been given *causa honoris* by any important institution.

It appears from the tables and from the data on which they are based that the humanities are favored at Harvard and Yale and the sciences at Johns Hopkins, Columbia and Cornell. Last year Johns Hopkins gave more than its proportionate share of degrees in chemistry, physics, zoology and physiology, Chicago in mathematics, geology, sociology and education, Harvard in physics, zoology and anthropology, Columbia in astronomy, botany, zoology and education, Yale in paleontology and psychology, Cornell in botany and psychology and Clark in mathematics, psychology and education.

The distribution of students among the different sciences for 1900 and for the two preceding years is as follows:

	1900	1899	1898
Chemistry	26	32	27
Physics	15	7	11
Botany	12	11	11
Mathematics	11	13	11
Zoology	11	11	12
Psychology	9	15	18
Education	8	5	—
Geology	5	5	6
Astronomy	4	2	3
Physiology	4	1	4
Sociology	3	5	—
Anthropology	2	0	2
Paleontology	2	4	0
Bacteriology	1	1	0
Mineralogy	0	2	0
Meteorology	0	1	0
	113	115	105

The names of those on whom the doctorate was conferred for work in the sciences and the titles of their theses are as follows:

JOHNS HOPKINS UNIVERSITY.

Homer Van Valkenburg Black: The Permanganates of Barium, Strontium, and Calcium.

William Martin Blanchard: The Chlorides of Parabromorthosulphobenzoic Acid and some of their Derivatives.

Hall Canter: Orthophenylsulphonebenzoic Acid and related Compounds.

Charles Edward Caspari: An Investigation of the Fatty Oil contained in the seeds of *Lindera Benzoin*. II. Lauric Acid and some of its Derivatives.

Hardee Chambliss: The Permanganates of Magnesium, Zinc, and Cadmium.

James Edwin Duerden: West-Indian Madreporarian Polyps.

Luther Pfahler Eisenhart: Infinitesimal Deformation of Surfaces.

Wightman Wells Garner: Action of Aromatic Sulphonchlorides on Urea.

Lawrence Edmonds Griffin: The Anatomy of Nautilus Pompilius.

Joseph Cawdell Herrick: The Influence of Variation of Temperature upon Nervous Conductivity, studied by the Galvanometric Method.

David Wilbur Horn: A Study of the Action of Carbon Dioxide on the Borates of Barium, and of the Action of Acid Borates on Carbonate of Barium at High Temperatures.

William Bashford Huff: The Spectra of Mercury.

Robert Edmund Humphreys: The Action of Phenol on the Chlorides of Orthosulphobenzoic Acid.

Charles Ranald McInnes: Superosculated Sections of Surfaces.

Austin McDowell Patterson: The Reduction of Permanganic Acid by Hydrogen and Ethylene and a Study of some of its Salts.

Louis Maxwell Potts: Rowland's New Method for measuring Electric Absorption and Energy Losses due to Hysteresis and Foucault Currents, and Detection of Short Circuits in Coils.

Albert Moore Reese: Structure and Development of the Thyroid Gland in Petromyzon.

Herbert Meredith Reese: An Investigation of the Zeeman Effect with reference to Cadmium, Zinc, Magnesium, Iron, Nickel, Titanium, Carbon, Calcium, Aluminium, Silicon and Mercury.

Richard Burton Rowe: The Paleodevonian Formations in Maryland: a study of their Stratigraphy and Faunas.

Elisha Chisholm Walden: A Plethysmographic Study of the Conditions during Hypnotic Sleep.

The University of Chicago.

John Charles Hessler: On Alkyl Malonic Nitrile Derivatives.

William McPherson: The Constitution of the Oxyazo Compounds.

Henry Chalmers Biddle: Ueber Derivate des Kuretins und der Formhydroxamsäure und ihre Beziehungen zur Knallsäure.

William Gillespie: Determination of all Hyperelliptic Integrals of the first kind of Genus 3 reducible to Elliptic Integrals by Transformations of the Second and Third Degrees.

Annie Marion MacLean: The Acadian Element in the Population of Nova Scotia.

Forest Ray Moulton: A Particular Class of Periodic Solutions of the Problem of Three Bodies.

Howell Emlyn Davies: The Occurrence of the Typhoid Bacillus in Typhoid Fever Patients.

Jacob Dorsey Forrest: The Development of Industrial Organizations.

Thomas Cramer Hopkins: The Genesis of Certain Limonite Ores of Pennsylvania.

Gilbert Ames Bliss: The Geodesic Lines on the Anchor Ring.

William Arthur Clark: Suggestion in Education.

Robert Francis Earhart: Sparking Distances between Plates for Small Distances.

Walter Eugene Garrey: The Effect of Ion upon the Aggregation of Infusoria.

Michael Frederic Guyer: The Spermatogenesis of Normal and Hybrid Pigeons.

Derrick Norman Lehmer: Asymptotic Evaluation of certain Totient-Sums.

William Newton Logan: A North American Epicontinental Sea of Jurassic Age.

John Hector McDonald: Concerning the System of the Binary Cubic and Quadratic with application to the Reduction of Hyperelliptic Integrals to Elliptic Integrals by a Transformation of Order Four.

Frank Lincoln Stevens: The Compound Oosphere of Albugo Bliti.

Ella Flagg Young: Isolation in School Systems.

Harvard University.

Harrison Hitchcock Brown: The Dialectic Constant of Water.

Roland Burrage Dixon: The Language of the Maidu Indians of California.

Waldermar Koch: Orthobenzochinone and some of its Derivatives.

Theodore Lyman: False Spectra from the Rowland Concave Grating.

William Edward McElfresh: The Influence of Occluded Hydrogen upon the Electrical Properties of certain Metals.

George Thomas Moore: A Contribution to the Knowledge of the Structure and Development of certain Unicellular Algae, with especial Reference to the Question of Polymorphism in the Chlorophyceae.

Harry George Parker: On the Occlusion of Baric Chloride by Baric Sulphate; A Revision of the Atomic Weight of Magnesium.

George Washington Pierce: Application of the Radio-Micrometer to the Measurement of Short Electric Waves.

Charles William Prentiss: The Otocyst of Decapod Crustacea: Its Structure, Development, and Physiology.

Herbert Wilbur Rand: A Study of the Regenerating Nervous System of Lumbricidae, with special regard to the Centrosome of Nerve Cells.

Charles Henry Rieber: Tactual Illusions: An Experimental Proof of the Spatial Harmony of Sight and Touch.

John Reed Swanton: The Morphology of the Chinook Verb.

Alvin Sawyer Wheeler: The Reduction Products of Dehydromucic Acid.

Stephen Riggs Williams: Changes Incident to the

Migration of the Eye in Pseudopleuronectes americanus, together with some Observations on the Optic Tract and Optic Tectum.

Amadeus William Grabau : Phylogeny of Gastropoda : I. The Fusidae and their Allies.

COLUMBIA UNIVERSITY.

George Neander Bauer : The Parallax of μ Cassiopeia and the Positions of 56 Neighboring Stars as deduced from the Rutherfurd Photographic Measures.

William Isaac Chamberlain : Education in India.

Caroline Ellen Furness : Catalogue of Stars within One Degree of the North Pole, and Optical Distortion of the Helsingfors Astrophotographic Telescope, deduced from Photographic Measures.

August Henry Gotthelf : The Action of Nitrils on Organic Acids.

David Griffith : The North American Lordariaceæ.

Tracy Elliot Hazen : The Ulothricaceæ and Chætophoraceæ of the United States.

Charles Judson Herrick : The Cranial and First Spinal Nerves of Menidia ; a Contribution on the Nerve Components of the Bony Fishes.

Aladine Cummings Longden : Electrical Resistance of Thin Films Deposited by Kathode Discharge.

Hermann Andreas Loos : A Study on the Constitution of Colophony Resin.

Frederick Clark Paulmier : The Spermatogenesis of Anasa Tristis.

Rudolph Rex Reeder : The Historical Development of School Readers and Method in Teaching Reading.

Frank Clarence Spencer : The Education of the Pueblo Child : a Study of Arrested Development.

CORNELL UNIVERSITY.

William Chandler Bagley : The Apperception of the Spoken Sentence.

Charles Edward Brewer : The Constitution of Galeïn and Coernleïn.

Kary Cadmus Davis : A Taxonomic Study of North American Ranunculaceae as found in Gardens or Native.

Stevenson Whitcomb Fletcher: Pollination in Orchards.

Charles Tobias Knipp: The Surface Tension of Water above 100° Centigrade.

Gertude Shorb Martin: The Dying Out of Uncivilized Insular Peoples in Contact with Modern Civilization—a Study in Social Selection.

William Fairfield Mercer : The Development of the Wings of the Lepidoptera.

Wilhelm Miller : Chrysanthemums.

Edward Charles Murphy : The Windmill : Its Efficiency and the Conditions of its Economic Use.

William Alphonso Murrill · The Development of the Archegonium and Fertilization in the Hemlock Spruce.

Guy Montrose Whipple : An Analytic Study of the Judgment-Process in Discrimination of Clangs.

YALE UNIVERSITY.

Joseph Barrell : The Geology of the Elkhorn District, Montana.

Ernest William Brown : Contribution to the Chemistry of the Formation of Uric Acid in Man.

Alexander Cameron : Tactual Perception.

Herdman Fitzgerald Cleland : A Study of Fossil Faunas in the Hamilton Stage of New York.

Joseph Hall Hart : The Action of Light on Magnetism.

Herbert Edwin Hawkes : Examination and Extension of Peirce's Linear Associative Algebra.

Cloyd North McAllister : Researches on Writing.

William Kent Shepard : A new Solution for the Copper Voltameter.

William Valentine : Researches on Substitution ; The Action of Bromine on Metachlor-, Metabrom-, and Metaiodanilines ; The examination of Thiolbenzoic Acid in regard to its action on compounds containing Amido, Imido, and Hydroxyl Groups.

George Reber Wieland : Osteology of Some Fossil Turtles ; A Study of American Fossil Cycads : 1. Geological Distribution ; 2. Structure of the Leaf.

CLARK UNIVERSITY.

John S. French : On the Theory of the Pertingents to a Plane Curve.

Frank B. Williams : Geometry on Ruled Quartic Surfaces.

S. Elmer Slocum : On the Continuity of Groups Generated by Infinitesimal Transformations.

Halcott C. Moreno : On Ruled Loci in n-fold Space.

Thomas Rich Croswell : Amusements of Worcester School Children.

Norman Triplett : The Psychology of Conjuring Deceptions.

Frederick Eby : The Reconstruction of the Kindergarten.

Willard Stanton Small : Studies of the Psychology of the White Rat.

Charles Herbert Thurber : The Principles of School Organization.

UNIVERSITY OF PENNSYLVANIA.

Morton Githens Lloyd : The Transversal Thermomagnetic Effect in Bismuth.

Anna Jane McKeag : The Sensation of Pain : an Experimental and Critical Analysis.

George Ward Rockwell : An Electrolytic Study of Pyroracemic Acid.

Charles Lawrence Sargent : Alloys of Tungsten and of Molybdenum obtained in the Electric Furnace.

Charles Hugh Shaw : A Comparative Study of the flowers of *Polygala polygama* and *P. pauciflora*, with a Discussion of Cleistogamy.

Albert Duncan Yocum : An Inquiry into the Fundamental Processes of Addition and Subtraction.

COLUMBIAN UNIVERSITY.

Eugene Byrnes : Experiments on the direct Conversion of the Energy of Carbon into Electrical Energy.

Charles Russel Ely : Investigation of Pheuomenon of Deliquescence and of the Capacity of Salts to attract Water Vapor.

Ernestine Fireman : The Action of Phosponium Iodide on Tetra and Penta Chlorides.

UNIVERSITY OF CALIFORNIA.

Walter Charles Blasdale : A Chemical Study of the Indument found on the Fronds of Gymnogramme triangularis.

BRYN MAWR COLLEGE.

Florence Peebles : Experiments in Regeneration and in Grafting of Hydrozoa.

UNIVERSITY OF MICHIGAN.

Eugene Cyrus Woodruff : The Effects of Temperature on the Tuning Fork.

UNIVERSITY OF MINNESOTA.

Bruce Fink : Contributions to a Knowledge of the Lichens of Minnesota.

UNIVERSITY OF NEBRASKA.

Charles Fordyce : The Cladocera of Nebraska.

PRINCETON UNIVERSITY.

Henry Norris Russell : The General Perturbations of the Major Areis of Eros caused by the Action of Mars; with the corresponding Terms in the Mean Longitude.

VANDERBILT UNIVERSITY.

J. Magruder Sullivan : Coal Tar Pitch and its High-boiling Fractions and Residue.

UNIVERSITY OF WISCONSIN.

Carl Edward Magnusson : The Anomalous Dispersion of Cyanin.

INERTIA AND GRAVITATION.

It was shown by J. J. Thomson ('Effects produced by the Motion of Electrified Bodies,' *Phil. Mag.*, April, 1881), that a charged body has more inertia than an uncharged one.*

* The formula there given contains a slight slip in the numerical coefficient, as was first pointed out by Heaviside. $\frac{1}{3}$ should be written for $\frac{2}{15}$.

In 1890* and 1891† the writer introduced, for the first time, the conception that it was not only, as in the electrochemical theories of Davy, Berzelius, Helmholtz, and others, atoms in chemical combination or the dissociated components of a molecule, which had charges; but that all atoms, even in such substances as metallic copper and silver, possessed charges, and that the so-called neutral atoms were not devoid of charges, 'but had equal quantities of both kinds of electricity.'

For practically a year it was found impossible to secure publication of this theory, the two principal objections which the editors to whom it was sent made to it being that in the first place it was a fundamental fact that all electric charges must reside on the outside of conductors, and that consequently the atoms of a conductor, such as copper, could not possibly have individual charges, and secondly that 'the atoms, being self-evidently conductors themselves, or else the metal as a whole could not conduct,' the postulated equal charges on the atoms would immediately neutralize each other. A brief note was finally published by the kindness of the editor of the *Electrical World* in that paper,‡ but accompanied with an editorial to the effect that though the numerical relations connecting the elastic constants with atomic volume, discovered by the writer and adduced as proof of the theory, were no doubt interesting, the theory was probably wrong, and the efforts due 'to intermolecular forces just about sufficient to account for the particular sort of strain which we know as an electric charge.'

The above is not mentioned for the purpose of discrediting the judgment of the editors referred to, for when even specialists did not, at a much later date, see that it could be reconciled with the physical facts,

* Lecture, Elect. Soc., Newark, May, 1890.

† *Elec. World.*, Aug. 8 and Aug. 22, 1891.

there is, of course, much excuse for those who were not specialists in this particular line. But attention is called to it as illustrating the general trend of ideas at the time when the writer first attempted to introduce his theory.

Some time later, in Europe, similar ideas were put forward by other writers, notably by Richartz, Lorentz, Chattock, Larmor and others, and at the present time the theory may be considered to be on a strong footing.

The theory thus originated by me, that the ionic charge is always associated with the atom, in all conditions, naturally led to the conception that it might be the inertia effect of such a charge, acting in the way first shown by J. J. Thomson, which caused the inertia of matter. This idea was advanced by several writers, amongst others by Dr. Kennelly. But it was easily shown, and had in fact been ascertained previously by the writer, and no doubt by others, that, with the known dimensions of the atom, this hypothesis was untenable, the effect so produced being only about 10^{-8} of that necessary.

In subsequent papers,* the writer put forward the idea that "the atoms may be formed of vortex rings arranged in different kinds of space nets, with the direction of rotation of the vortex rings such as will make these combinations stable," and that "one might picture to one's self a vast portion of the 'atom dust' from which Mr. Spencer develops his universe, made of vortices and splitting up in these 67 ways to form the elements."

This hypothesis had for some time no real foundation. During the past year, however, the wonderful work of J. J. Thomson has resulted in almost certain proof of the fact that the atom is really made up of a large number of what he calls 'corpuscles,' each possessing an electric charge. In this paper (in the December number of the *Phil. Mag.*, 1899), Thomson recurred to the question of inertia being an electrical effect, but considered that there is at present no evidence to decide whether the corpuscles are small enough.

In 1891 the writer had shown that the atoms of a body in the solid state must be nearly touching each other, and that the phenomena which were supposed to militate most strongly against this supposition could be accounted for in a very simple manner. In a later paper* (read before the A. A. A. S., Columbus meeting, August, 1899), I showed that though the atoms were nearly touching each other, yet they really filled less than ½ per cent. of the space which they occupied to the exclusion of other atoms.

From the two facts, *i. e.*, Thomson's discovery that the number of corpuscles in a hydrogen atom is of at least the order of one thousand, and the writer's discovery that the real volume of the atom is but a small portion of the space occupied by the atom, we arrive at the conclusion that the atom must be made up of a large number of corpuscles separated from each other by distances considerably larger than their diameters. This gives us data for making an approximate estimate as to the ability of the corpuscular charges to account for the inertia of the atom, and on making this calculation, we find, as the writer has shown,† that it really is the probable cause.

In other words, we may feel fairly confident that inertia is really not a separate and distinct thing, but merely a property due to the fact that the atom is made up of a very large number of electric charges.

I have recently found that gravitation can also be accounted for as a property

* Articles on Insulation, *Elect. World*, March, 1893, *et seq.*

* 'A Determination of the Nature of the Electric and Magnetic Quantities and of the Density and Elasticity of the Ether,' *Phys. Rev.*, January, 1900.

† 'Inertia.' *Elect. World*, 1900.

of these same corpuscular charges. It was first pointed out by Newton that if the density of the ether continually increased as we move away from a particle of matter, that we should obtain a gravitational effect. Later it was shown by other writers, notably by Kelvin, that the same result would follow if the density decreased. No way of accounting for this continuous variation of density has as yet been suggested. Again, it was shown by Maxwell that on any stressed medium theory of gravitation, the stresses must be enormous, whilst the estimates given by Kelvin of the elastic constants for the ether were not such apparently as to permit of this. But the writer showed, in the paper above referred to, that the elasticity of the ether is immensely great, *i. e.*, 6×10^{20}. Now if we calculate, as I have done in one of the papers referred to, what the diameter of the corpuscle must be, in order that it shall give the inertia effect, and from that calculate the electrostatic stress at the surface of a corpuscle, we find that it is of the order 10^{20}, and this stress acting on a medium whose elastic coefficients are as given, I have found, can produce a change of density sufficient to give the observed gravitational attraction.

We thus find that both inertia and gravitation are electrical effects and due to the fact that the atom consists of corpuscular charges. The constant ratio between quantity of inertia and quantity of gravitation, for a given body, is thus explained. We may state the theory thus:

The inertia of matter is due to the electromagnetic inductance of the corpuscular charges, and gravitation is due to the change of density of the ether surrounding the corpuscles, this change of density being a secondary effect arising from the electrostatic stresses of the corpuscular charges.

A fuller paper on this subject is in course of preparation, but will be delayed for some time by pressure of other work.

I may here mention that I have found that the equation

$$M/L^3 = M/LT^2 \times T^2/L^2,$$

given in the paper in the *Physical Review*, above referred to, and stated to represent a phenomenon not yet discovered, really represents Kerr's electrostatic optical effect, and the above gravitational effect, and that this effect therefore varies directly with the elastic coefficient of the dielectric. As this is one of the remaining links necessary to complete the full chain of proof of the theory there given, this latter is thus put upon a still firmer footing.*

The weight of matter in a gaseous state should be very slightly greater than in the solid state, and iron should weigh slightly less when dissolved. It is doubtful, however, whether the experimental conditions are not too difficult. If the measurement could be made it would give an independent method of arriving at the size of the corpuscle.

The writer has pointed out that the Kelvin-Maxwell theorem, deduced from the phenomenon of the electromagnetic rotation of light, that whenever we have a magnetic field we have also a rotation of the medium, is incorrect, in that it assumes that light consists of a certain kind of periodic motion for which there is no evidence. The question arises: In spite of the fact that the supposedly general theorem is incorrect, is there any actual material rotation concerned in the electromagnetic rotation of light? The answer I would give is 'yes, but not as a cause, merely as an effect.' According to the theory advanced by the writer,† the rotation is a consequence of light absorption, and can only take place in an absorbing medium. When the light waves strike the atoms, if the period of vi-

* A Determination of the Natnre of the Electric and Magnetic Quantities. *Phys. Rev.*, January, 1900.

† *Ibid.*

bration of the corpuscular groups is very different from that of the waves, there is no absorption, and the light passes through unchanged. But at or near synchronism the group is set in vibration and causes the electric displacement to lag behind the voltivity. Hence, the group being set in vibration, and being in a magnetic field, it must, as was first pointed out by the writer,* and later by Lorentz, rotate. But this rotation is not a *cause* of the light rotation, but an effect.

Reginald A. Fessenden.

THE WORK OF THE SOCIETY FOR AGRICULTURAL EDUCATION.†

During the sixties in the Agricultural College, with which I have long been connected, one professor taught classes in agriculture, animal physiology, veterinary, breeds of live stock, stock feeding, farm crops, civil engineering, and was superintendent of the farm. In recent times this work has been placed in the hands of a dozen or more persons. I need not enumerate similar instances of the recent division of labor as exemplified in our universities. This is a day of specialists and the end is not yet.

The American Association for the Advancement of Science, which we shall attend here next week, when first organized had no sections, but the members all met together as long as the meetings continued. By degrees, as you all know, they increased till there are now nine sections, each with a full quota of officers, not to mention some sub-sections.

Recently, as though this was not enough, there have been formed a considerable number of distinct organizations, the programs of some of which contain much the same range of papers, presented mostly by the same members as those in the parent society.

Meetings during this week and next will be held here by fifteen affiliated societies.

In December, 1898, nine separate societies met during the same week at this university, and nearly every paper presented would have been received by some of the sections of the American Association.

The Fifth Congress of American Physicians and Surgeons was held at Washington, D. C., on May 1st, 2d and 3d. Fourteen distinct societies joined in the triennial Congress.

In much the same way journals occupying special fields of science have multiplied.

Previous to 1880, a number of American societies were organized for the discussion of agricultural topics and those of a kindred nature. For several reasons most of these survived only long enough to hold from one to three meetings.

In 1880, at Boston, a new plan was tried, viz, that of organizing the Society for the Promotion of Agricultural Science, consisting of twenty-one persons. It was the determination of its members to strive for papers of genuine worth and make no effort to draw crowded houses or to make a great display in any manner, whatever. The Society after continuing for twenty-one years has demonstrated beyond question that it is entitled to live and has important work to perform. In all, up to this time, there have been only one hundred and ten members. Those who have continued active, have been too conservative to suit a very few who were impatient for large numbers and more display. To most of us, it seemed of first importance to become acquainted with each other and learn the peculiarities of the members. Some men are restive and never remain active in any society for a very long time. Such may be expected to drop out and others will be elected to fill the places left vacant. Had

* *Elect. World*, May 18, 1895.

† President's Address at the Twentieth Meeting of the Society for the Promotion of Agricultural Science.

the membership been offered to all who sought it, there is little doubt that the Society would have scarcely survived long enough to hold ten annual meetings. As it is the membership has gradually increased and is larger than ever before, with other capable men ready to seek admittance. The Society was never so strong as it is to-day and the chances are that with wise management it will long continue to strengthen.

Every person who has long been an active member of any of the societies above mentioned, and many others, must be aware that a few persons in each need to continually exert themselves to prevent the death of the Society.

Probably there is no exception to the general rule that, a society like a business enterprise, before meeting with any marked degree of success must pass through some trials, metaphorically, must have the mumps, the chicken pox, measles, whooping cough, the grippe, after which, if it stand the strain well, it may be ready to engage in successful work.

In 1887, Congress began appropriating to each state and territory $15,000 a year for conducting experiments in agriculture. During the same period, the U. S. Department of Agriculture has rapidly extended its work, covering almost every conceivable field of agriculture and even some beyond its limits. The chiefs, and assistants and students are usually most capable and number all told over 600 persons.

The work performed by the Department is stupendous, covering a range of topics in a most creditable manner, and the value to the country is beyond estimate. To facilitate the work of experiment stations, including the agricultural colleges, and a small number from the department of agriculture, an annual conference of delegates is held once a year. Not only are the traveling expenses of these delegates paid, but the proceedings are printed and widely distributed by the government. Some have said, "Why isn't this an ideal plan, and why cannot these delegates from college and station perform all that it was intended should be done by the Society for the Promotion of Agricultural Science?" Here is the answer: (1) The presidents of the colleges and the directors of the stations are almost the only persons who attend these conferences oftener than once or twice in five years or more, and most of those who perform the experiments are never sent to the meetings. This scarcely gives any opportunity for the experimenters and professors of the colleges to maintain a continued interest in committee work and in other respects. For these reasons and others, a considerable number of them have become discouraged and advise standing by the Society for the Promotion of Agricultural Science. (2) Not two-thirds of our members are connected with any experiment station in the United States, and therefore, are ineligible as delegates to the meetings. (3) The time for holding the meetings of the station delegates comes at a season of the year when the teachers are busy in laboratory and class room. (4) Other reasons at this time need not be given.

It is not only a pleasant privilege, but a duty, even a necessity for teachers of various sciences and arts in agricultural courses to meet occasionally for acquaintance, each helping the other. Every year new subjects are developed and new and improved methods are discovered for demonstration. He who does not continually exert himself, will soon fall behind the race. No where is this more apparent than in agricultural colleges and experiment stations, for their work is of recent origin.

As athletics in these times interests nearly all students in a university, so the modern trend of agricultural education interests every one of our members. We are all interested in aiming to shape good courses in agriculture, each championing his own department.

Almost any one in short order can place on paper groups of studies for each term of four years and call it a course of study, but to begin at the right end, experimenting and working out all the details of each topic, assigning reasons for each, before generalizing, classifying and grouping into courses requires much time, patience, skill and mature judgment. Nor can we ever expect to secure a uniformity in courses of study for different colleges. These must vary in different states to correspond to the demands of the people, the views of the faculty, and the special fitness of the members of the faculty for teaching certain topics. For twenty-five years I have been at work adjusting courses in agriculture to suit the views of myself and many new men as they entered the faculty from time to time. No two professors of agriculture or horticulture think alike. Besides great advances are all the time being made. There have come along one after the other or by twos and threes during thirty years, a host of new things, each clamoring for a place in the course, such as plant histology, parasitic fungi, the botanical study of grasses and other forage plants, the critical study of weeds from various stand points, forestry, the use of insecticides and fungicides, soil physics, stock feeding from the scientific side, growing beets and making sugar from them, making butter and cheese with scientific explanations for every step of the process, and smallest of all, though by no means of least importance, the little microbes as helps and hindrances to agriculture.

Some of our members are especially trained for the work of adjusting courses of study from time to time, to keep up to date, but to plan a course of study in agriculture which shall remain satisfactory and up with the times for more than a year or two at a time will be as disappointing as to attempt to deliver a course of lectures that shall not need remodelling in many particulars every year or two.

This is the way President Eliot put the question in his annual report for 1888–1889:

"A problem has been pressing upon every member of the board, old or young, experienced or unpracticed. During recent years every college teacher has been forced to answer anew the personal questions—What can I best teach, and how shall I teach it? Every man has really been obliged to take up new subjects and to treat them by new methods. There is not a single member of the faculty who is to-day teaching what he taught fifteen years ago as he then taught it. Each teacher has had to recast his own work, each department repeatedly to modify and extend its series of courses, and the faculty as a whole, to invent, readjust, and expand the comprehensive framework within which all these rapid changes and steady growth have taken place."

Notwithstanding all this, we must keep diligently studying to perfect even for the time, a schedule of studies, approaching nearer and nearer the ideal, though we never attain perfection.

University extension work has become a familiar phrase. Some professors and assistants in universities now devote all their time to the subject, while others devote a limited portion of time. The entire contents of magazines dwell on extension work.

In 1857, the first students entered the oldest agricultural college now in existence in this country. That was 43 years ago in April last. Such colleges had no pattern to follow, no men trained to the work; most of the farmers from the start were confident that such institutions would prove of no value; it was entirely against tradition. The colleges dwindled with a very short roll of students with no end of ridicule. What was to be done? If the farmers would not send their sons to the colleges nor encourage their support, it was only a question of a few years when all such enterprises must be abandoned. Congress had made liberal endowments. If the farmers will not go to the colleges, then the colleges must go to the farmers. It was a matter of necessity. University extension is the taking of the university or college to the people, when the people cannot or will not go to the college or university.

According to H. B. Adams in the *Forum* for 1891, page 510, "The movement originated in the year 1867 in academic lectures to the school teachers and working men of the North England by Professor James Stuart of Cambridge, now member of Parliament."

A course was given in Great Britain by some of the professors in Cambridge University in 1873.

So far as I know the following account explains the origin of extension work in this country, at least its connection with agricultural colleges. On August 30, 1871, the trustees of the Illinois Industrial University, now known as the University of Illinois, passed a resolution that the regent and corresponding secretary be authorized to make such arrangements for holding, during the coming winter, Farmers' Institutes, at the University and in other parts of the State, as they might find advisable. Several institutes were held that year and others in succeeding years. The circular said, "We want to bring the live practical men and the live scientific men together that all may be benefited."

The regent of the University, Dr. J. M. Gregory, was the leading spirit in starting institutes in Illinois. Early in 1876, Michigan Agricultural College held her first institutes. Note that Illinois University began University extension two years before Cambridge in England. The rapid increase in the number and efficiency of institutes in most of the northern states is a subject familiar to all of you. A generation of objectors to good Agricultural Colleges has passed away and their places are occupied by those who are attentive and enthusiastic. Praise and support of the agricultural college has taken the place of apathy and criticism, and extension work has done it. More recently, beginning in 1888 to 1890, a considerable number of universities and colleges in this country have undertaken extension work in variety. Perhaps some of them saw the benefit that followed such efforts, made by the agricultural colleges. Itinerant instructors have been employed to work among manufacturers of butter and cheese in Canada and Wisconsin. In New York, special schools, enduring for a week, for giving instructions in horticulture, were held in many country school districts.

Extension reading courses are accomplishing something. Almost every plan conceivable has apparently been tried to arouse and attract men toward better methods in agriculture as aided by a scientific education. One of the most recent of these movements in agricultural education is the introduction of what is known as 'Nature Study' or 'Elementary Science' in the rural schools. We are most fortunate at this meeting in having with us an honored member who is brim full with experience and enthusiasm concerning this important subject. We are eager to listen to what he shall say. I am sure that I voice the opinion of every member of this Society when I say that we all favor a liberal education. None of us could dispense with mathematics, one or more languages and other substantial knowledge to be acquired in completing a course of study in any college in the land. Mathematics, Latin, rhetoric, history, physiology, English literature, political economy, ethics, chemistry, zoology, botany and other branches of learning are placed in college courses, not necessarily because some of them give a better training than others, but because their study trains the person in different directions. A good course of study for the mind is comparable to a symmetrical training for the body, one develops many mental faculties, the other many of the muscles of the body. As the last echoes of the conflict between the champions of the classics and the natural sciences have not yet died away, will you permit me to refer briefly to the subject at this time? The opinions of educated men who lived eighty or ninety years ago are not to be taken in evidence in the matter, as there was no natural science in those days comparable to that of the present day. Nor can the opinions of philologists be taken without some degree of allowance, as their judgment is liable to be biased and one-sided, unless they have also had the benefit of a thorough training in botany and zoology for at least three years. They claim much for a study of Greek or Latin continued for four to five years, while they do not see great advantages in studying botany and zoology for one or two years. I will try to point out as fairly as I can some of the peculiar training afforded by three selected types of studies, viz, Mathematics, Latin and Botany.

(1) The utility of the study of mathematics is granted by every educated person. (2) There is no substitute for mathematics as a training in exact reasoning. (3) By this study a student learns to use concise language. (4) A clear statement is given, and step by step an inevitable conclusion is reached which is clear and accurate. (5) Here we find excellent examples of deductive reasoning.

The study of Latin (1) cultivates and strengthens the memory. (2) The faculty of attention or mental concentration is developed, that is, the successful student learns the significance of genuine study. (3) The perceptive faculties are well trained. (4) The study of Latin should lead to clear and concise speech and help to a better understanding of English. (5) Latin has an obvious etymological value, helping to understand the meaning of many English words. (6) It gives a training in the use of synonyms. (7) Latin cultivates the power of interpretation. (8) It exercises skill of a peculiar kind to observe all the shades of meaning of each Latin word in a long and intricate sentence and then translate it into clear and elegant English. (9) It requires the most discriminating use of the eye, mental alertness, the imagination, and the judgment. (10) There lies a thought clothed in Latin words; it is to be expressed in correct English. (11) The study enables one to get some of the best thoughts at first hand.

The advantages claimed for the study of botany are: (1) There is nothing better for training the powers of observation. (2) The comparison of one plant or one part of a plant with another cultivates the power of inductive reasoning. (3) In learning the definitions of new words, the memory is strengthened, the vocabulary enlarged. (4) There is nothing better to train the power of precise and brief description in using each word with a definite meaning. (5) To follow successive changes that take place in shape, proportion, size, color, as seen in one plant from seed to maturity, develops the observation, powers of description, and the judgment. (6) By experimenting to learn the results that follow changes in temperature, light, moisture; by mutilating or removing certain parts, many facts may be obtained enabling one to arrive at certain correct conclusions. (7) To become acquainted with the minute anatomy of plants by the aid of sections made in different directions and seen with a compound microscope cultivates the imagination as well as the powers of observation and reasoning. (8) The preparation of materials for examination trains the hand to precision as well as the eye and the judgment. (9) "In studying botany a student gains in analytic and synthetic powers," T. C. Abott. (10) "It is the best system of practical logic, and the study exercises and shapes at once both the powers of reasoning and observation, more probably than any other pursuit," Asa Gray, who possessed a good knowledge of mathematics and Latin as well as of botany.

What shall I say of the value of training acquired by studying bacteria and lichens, by experimenting to demonstrate that certain fungi, like wheat rust and many others, assume two distinct forms on each of two different host plants? Here is need of extreme care to eliminate all sources of error. Facts are at length acquired (not given) and correct inevitable conclusions reached.

Take one step into the domain of horticulture. Selecting the parents and crossing one species or variety of plant with another, with the view of securing new and improved sorts, command the use of the eye, hand, imagination, keen judgment, and the experience of experts.

In selecting and matching apples suitable to exhibit at a fair, the eye, the sense of smell and taste and feeling, as well as the judgment are called into action.

Mathematics starts with definite indisputable facts to demonstrate a proposition.

Latin is based on usage and authority, not on proof. In botany the facts are first to be discovered and then a truth demonstrated. This is the process of reasoning in a large per cent. of all practical matters of life. Linguists claim that the student should devote four to five years to the study of Latin, while one or two years is considered ample time for botany. Let the student devote a year or two to Latin and four or five to botany and then make the comparisons.

You might naturally expect me to quote a few statements from Herbert Spencer. Here they are, old, but good:

"The education of most value for guidance, must at the same time be education of most value for discipline." "One advantage claimed for that devotion to language learning is that the memory is thereby strengthened. But the truth is, that the sciences afford far wider fields for the exercise of memory." "And when we pass to the organic sciences, the effect of memory becomes still greater." "While for the training of mere memory, science is as good as, if not better than language; it has an immense superiority in the kind of memory it cultivates. In language the facts are in a great measure incidental; in the acquirement of science, the connections of ideas correspond to facts that are mostly necessary. While the one exercises memory only, the other exercises both memory and understanding. A great superiority of science over languages as a means of discipline, is that it cultivates the judgment to a greater degree."

"The learning of language tends further to increase the already undue respect for authority. Quite opposite is the attitude of mind generated by the cultivation of science, which appeals to individual reason. Every step in a scientific investigation is submitted to the judgment. It exercises perseverance and sincerity." "In all its effects learning the meaning of things, is better than learning the meanings of words." I may have made a mistake in making this digression, but it is now all over.

I think the most thoroughly educated people are now agreed that the method of pursuing a study is of more importance than the selection of a subject. They believe that botany or zoology well taught, for the same length of time, affords as much discipline and culture as Latin, Greek or philosophy. But you may weary of this.

The programs of our meetings always announce some papers which have a scientific bearing on agriculture, forestry or some kindred line of business. As our members are specialists, it is fitting that we have each year a number of addresses of a general nature, such as summaries of progress, methods of experimenting, methods of teaching certain subjects, short syllabi of courses of study, and new points of general interest. These will be understood and will interest all, and will be likely to provoke a general discussion by the members.

The work of this Society during the past twenty years has apparently had a marked influence on the selection of subjects for discussion in some of the societies of this country. As an instance of the practical tendency of these subjects, if I may so express it, I cite you the admirable address of Vice-President Gage a year ago before Section F, of the A. A. A. S. at the Columbus meeting on 'The Importance and Promise in the Study of Domestic Animals.' Here are two sentences: "It is most earnestly believed, however, that in the whole range of zoology, no forms offer a greater reward for the study of the problems of life, especially in the higher groups, than the domestic animals. The importance of the study cannot be over-estimated from a purely scientific standpoint, and certainly if the prosperity, happiness and advancement of the human race are put in the count the subject is of transcendent importance."

Reference of a like nature might be made to numerous programs of scientific societies, to courses of study in colleges and universities, to contributions to the best scientific journals of the day, but no argument on the subject is needed at this time, for the reason that no observing person can be found in this audience who does not already recognize the truth of the statement that I have last made.

I thank you for the high honor of choosing me president for a third time, and congratulate you on the excellent prospects for a successful meeting on this, its twentieth year, and predict that a long and useful career yet remains for the Society for the Promotion of Agricultural Science.

W. J. Beal.
Agricultural College, Mich.

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*THE BRITISH ASSOCIATION.**

For the second time, after a lapse of 27 years, the British Association will meet in Bradford in the beginning of September. Not a few of those who attended the first meeting are still alive, some of them being among the most distinguished of our living men of science. There is no doubt that a certain number of those who attended the previous meeting will again be present in Bradford next month. They will notice a very great change in the town; it has grown enormously; it has been to a large extent rebuilt; and it has been raised to the dignity of a city, while its population has probably doubled. Bradford will have much to show to those who are interested in the many practical applications of science. There will be abundant hospitality, receptions, dinners, a smoking concert, excursions to places of interest in the neighborhood, and other forms of entertainment for those—and they are many—who regard the annual British Association meeting as a gigantic picnic.

The meeting of 1873 was presided over by Professor A. W. Williamson, the distinguished chemist, whose presidential address consisted mainly of a review of the progress of chemistry up to that date. The advance in this, as in other directions, since then has been enormous. The president selected at the previous meeting had been the late distinguished physicist, Dr. Joule, but owing to the state of his health he had to forego the honor of presiding at the first Bradford

* A forecast from the London *Times*.

meeting and his place was taken by Professor Williamson. Among some of the well-know representatives of science who were present at the Bradford in 1873, and who are now no more, we may mention the names of Cayley, Clifford, H. J. S. Smith, W. Spottiswoode, Clerk-Maxwell, Balfour Stewart, W. B. Carpenter, John Phillips, Gwyn Jeffreys, Rutherford Alcock and Dr. Beke. The economic section was presided over by W. E. Forster, and it is of some interest to note that the present popular assistant general secretary, Mr. George Griffith, occupied the same position in 1873 that he does now, although for several years in the interval he ceased to be an officer of the Association. The first Bradford meeting had an attendance of close on two thousand, and the grants made for scientific research reached the considerable sum of £1685.

The second Bradford meeting will be presided over by Professor Sir William Turner, who for so long has filled with such distinction the anatomical chair of Edinburgh University. His address will consist of a general review of the progress of Biology, with special reference to our knowledge of the structure and function of cells. The program of work in the different sections leads one to expect that the proceedings will be of considerable scientific interest.

The president of Section A (Mathematical and Physical Science) will be Dr. Joseph Larmor, F.R.S. In opening the business of the section Dr. Larmor will review the change of ideas which has recently become current regarding the scope and method of physical explanation. The acceptance on the Continent, in consequence of the brilliant work of Hertz, of the views originated in England regarding the nature of electric actions and their dependence on the ether has been largely accompanied by an elimination of the dynamical explanations which formed a main feature of Clerk-Maxwell's theory. This makes it a matter of fundamental importance to determine, if possible, how far purely descriptive methods can avail without appeal to a dynamical foundation; it involves consideration of the mode of representation of the physical activities of the material atoms; and it raises the question whether denial of direct action at a distance necessarily implies transmission by simple stress such as occurs in a material elastic frame. As chairman for the department of Astronomy, Dr. A. A. Common will give an address on Friday morning. Monday will be devoted to Meteorology and Pure Mathematics, while a discussion on ions will be introduced by Professor Fitzgerald on Tuesday.

Section B (Chemistry) will be presided over by the distinguished chemist Professor H. W. Perkin. The subject of his address will be 'The Modern System of Teaching Practical Inorganic Chemistry, and its Development'; and, after discussing the progress which has been made in the teaching of practical chemistry in schools, he will point out that during the last thirty years very little similar progress has been made in teaching inorganic chemistry in universities and colleges. Having shown that the system adopted at the present day is practically the same as that taught thirty years ago, Professor Perkin will next proceed to give a historical sketch of the development of this system, and will conclude his address with a discussion of the question whether the present system is the best and most suitable for teaching practical inorganic chemistry, or whether it might not with advantage be considerably modified. The greater part of the time of the Section will be devoted to discussions on (1) the chemistry of camphor, to be opened by Dr. Lapworth; (2) the questions raised by recent work on metals and alloys, to be opened by Mr. W. H. Neville, F.R.S., of Cambridge, in the course of which it is to be hoped that the important question "What is a metal?" may be settled; (3) the recent developments in connection with asymmetric structure in carbon and other compounds, to be opened by Mr. W. J. Pope, of the Central Technical College; and (4) the recent improvements in the textile industries (including artificial silk, etc.), to be opened by Dr. Liebmann. Among other papers promised are: 'Some Recent Work on the Diffusion of Gases and Liquids,' by Mr. Horace T. Brown; 'Determination of the Spectra of Gases at 400° C.,' by Professor Dixon; and 'On the Relationship between the Heating and Lighting Power of Coal Gas,' by Mr. T. Fairley. A paper of great local interest will be one on the treatment of woolcombers' effluents, by Mr. W. Teach; while the relations of phosphorus, iron, and carbon when present in iron and steel will be discussed by Mr. J. E. Stead, of Middlesbrough. Papers have also been promised by Professor Smithells, Dr. Laurence, Dr. J. B. Cohen, and Mr. F. W. Richardson. Professor Ewing and Mr. Rosenhaim will show slides illustrating the effects of strain and annealing on the crystalline structure of metals.

The Geological Section (C) will have as its president one of the most unconventional and brilliant of the younger geologists—Professor W. J. Sollas. The subject of his address will be 'Evolutional Geology.' The transformation of the science during the latter part of the 19th century, by which its scattered teachings have been organized into a compact body of doctrine and the whole science placed on a more philosophic basis, will be briefly alluded to. An account will be given of the development of the earth, including its early evolutional stages, which were once considered alien to geology. Its distribution in time will be particularly considered, and the dates of various critical periods in its history will be discussed.

As befits the *locale* of the meeting, the Section will devote especial attention to the carboniferous rocks, and particularly to the coal measures. One of the important events of the meeting will be a joint discussion with the Botanical Section (K) on the conditions which existed during the growth of the forest which supplied the material for coal. This is set down for Monday, September 10th, and the discussion will be opened on behalf of the geologists by Mr. A. Strahan, of her Majesty's Geological Survey (who for some time past has been engaged in supervising the mapping of the coal fields of South Wales), and Mr. J. E. Marr, F.R.S., a past-president of the section. It is expected that several other prominent geologists who have devoted attention to the coal measures will take part in this discussion. The same rocks will form the subject of a paper by Mr. Walcot Gibson, of her Majesty's Geological Survey, who will deal with their rapid changes in thickness and character in the North Staffordshire coal field; and Mr. W. Cash, of Halifax, will also contribute a paper on the Lower Coal Measures of the West Riding. The fossil fishes of the local carboniferous rocks will be discussed in two papers by Dr. E. D. Wellburn, and the report of the committee for investigating life-zones in our carboniferous rocks will be presented by the secretary, Dr. Wheelton Hind. Another topic of general as well as of local interest which will receive the attention of the section is the underground water system in the carboniferous limestone districts of the West Riding. The Association last year made a grant of £40 to assist in the investigation of the underground course taken by streams which disappear into crevices of the limestone in the neighborhood of Ingleborough. By the free use of chemicals the committee appointed to carry out this investigation has traced the underground course of some of these waters to their issue in springs at lower levels, with unexpected results, which throw much light on the general question of the percolation of waters through rock-fissures. The committee will present its report during the meeting, and excursions are being planned to visit the site of the experiments. As usual, glacial subjects will receive due attention, among the papers already promised being one on the glaciation of the Aire Valley by Messrs. H. Muff and A. Jowett, while others are expected on the glacial phenomena of Snowdon and on a similar subject in parts of the East Riding of Yorkshire. Three of the reports of committees of research will also afford scope for the discussion of glacial matters, viz: That on the erratic blocks of the British Isles, that on the conditions of occurrence of Irish elk-remains in the Isle of Man, and that on the Pleistocene deposits of Canada. The last mentioned, which is the final report of a committee appointed at the Toronto meeting of the Association, is likely to receive particular attention, as it embodies strong evidence in favor of the much-disputed occurrence of an inter-glacial period. It is expected that Professor A. P. Coleman, of Toronto University, who has been most active in the last mentioned committee, will attend in person to read the report. The same gentleman will also read a paper on the recent discovery of a ferriferous horizon in the Huronian rocks in Ontario, north of Lake Superior—a discovery which may eventually prove of great economic consequence. Cave-exploration in Ireland and at Uphill, near Weston-super-Mare, will be reported on by two committees of the Association. A further contribution to our knowledge of the geology of Anglesey will be made by Mr. E. Greenley, and Mr. Vaughan Cornish will bring forward the new results of his study of ripple-marks. In short, all the indications point to a profitable and enjoyable week for the geologists who visit Bradford.

Dr. R. H. Traquair will be president of Section D (Zoology), with which, on this occasion, Physiology will be combined. Dr. Traquair in his address, will deal with the 'Bearing of Fossil Ichthyology on the Doctrine of Descent.' Major Ronald Ross will contribute a paper on 'Malaria and Mosquitoes'; Messrs Gamble and Keeble on 'The Color Physiology of certain Marine Crustacea'; Professor L. C. Miall on 'The Respiration of Aquatic Insects.' In addition there will be, as usual, a number of communications of a more special character in all branches of natural history, together with the reports of various committees on the results of exploration and research.

Section E (Geography) will be presided over by Sir George Robertson, whose address will deal mainly with certain geographical aspects of the British Empire. He is likely to have much to say on the important element of distance and its diminution by means of improved communications. This Section is likely to be as attractive as usual. Sir Thomas Holdich will deal with the important subject of railway connection between Europe and Asia. Captain Deasy, Captain E. S. Grogan, and Mr. Borchgrevinck will repeat the story of their various expeditions in Asia, Africa and the Antarctic. Mr. E. G. Ravenstein and Mr. B. V. Darbishire are both to deal with the subject of colonial and foreign surveys. Mr. G. G. Chisholm has undertaken to deal with the important subject of the probable economic relations of Siberia and China. There will be one or two papers on the position of geographical teaching in Bradford and the neighborhood. Dr. H. R. Mill will deal with the geography of South-West Sussex, and Mr. E. Heawood with the commercial resources of Africa.

Section F (Economic Science and Statistics) will have as its president Major P.

G. Craigie, of the Department of Agriculture. In his address he will probably dwell on the care necessary for the properly scientific use of statistics and, above all, on the caution required in making international comparisons, illustrating his text, probably, with some of the better-proved figures which enable us to measure the development or retrogression of agriculture in different and typical countries. Doubtless owing to the fact of Major Craigie's being president, Section F this year will receive an unusual number of contributions relating to the economics of agriculture. Professor James W. Robertson, Dairy Commissioner of the Agricultural Department of the Dominion of Canada, and Professor William Saunders, LL.D., director of the Dominion experimental farms, will read papers, and Mr. A. D. Hall, of the Agricultural College of Wye, will deal with the economic possibilities of the growth of sugar beet in England, while a committee of the Section will at length present their report on the effect on prices of options and dealings in futures. There will be, as usual, a day devoted to what are roughly described as municipal subjects, and here Mr. Auberon Herbert is expected to condemn root and branch all attempts of local authorities to provide houses. Several interesting papers will be forthcoming on miscellaneous subjects. Mr. L. L. Price will deal with some economic consequences of the South African war, and the Hon. W. P. Reeves, Agent-General for New Zealand, will contribute a paper on the somewhat novel subject of 'The Colonies as Moneylenders.' Dr. Marcus Rubin, chief of the Royal Statistical Bureau of Denmark, will discuss some recent movements of population. There will also be several papers on questions of labor and wages. The historical school will be represented by Dr. W. Cunningham, who contributes a paper on North American paper currencies during the colonial period.

Sir Alexander Binnie will preside over Section G (Mechanical Science), and his address will take the form of an inquiry into the steps by which we have arrived at our modern conception of nature, when reviewed from a scientific standpoint. He will point out the reasons why the philosophers of Greece missed the true interpretation of nature, and, passing on to the Roman period and the dark ages, will show how there has gradually grown up the conception with which we are all so well acquainted and with which before us, when studying natural phenomena, the mind is freed from all preconceived notions derived from other realms of study. The address will be illustrated by a chronological chart likely to prove useful to all scientific men. It extends from 1550 to the present time, and includes, collated with the births and deaths of the many distinguished men to whom we are indebted, the principal historical, scientific, and other *data* which mark the various periods, as well as the dates of discoveries and of publications bearing upon the subject. There is, as usual, a large number of papers down for reading in this Section. We can only refer to the more important. The very fine waterworks belonging to Bradford will be described, on Thursday, by Mr. Watson, a local engineer. On Friday the papers will be mainly devoted to civil engineering. Professor Hele Shaw proposes to collect together, in his paper on 'Resistance on Roads,' all the known *data* on frictional resistance on common roads, and will, it is believed, strongly advocate the appointment of a committee of the Association to carry on some further experiments on rolling friction on common roads. The immediate value of the paper by Mr. J. H. Glass, on 'Proposed Railway Construction in China,' is likely to be lessened by the terrible events which have happened there since his paper was promised. His plan is to describe the great trunk line which it was intended to construct in Southern and Central China, and to give some account of the immense mineral wealth which lies there almost undeveloped. The paper will be illustrated by many beautiful lantern slides reproduced from photographs. For Saturday there are down two papers, dealing with the great staple industry of Bradford and Yorkshire —textile manufacture. They will describe the more modern methods of mechanical and photo-mechanical designing for textile fabrics, and will be read by Professor Beaumont and Mr. Barker, who are both engaged locally in the technical teaching of textile work. Monday, as usual, will be given up to the electrical engineers. First on the program for the day comes the reading of the final report of the Small Screw Gauge Committee, which has now practically decided which form of thread it will advocate. Mr. A. Mallock will then deliver a paper paper on 'Resistance and Acceleration of Trains—Measurement of the Tractive Force,' in which he proposes to give an account of the recent experiments made by him on electric and other railways to determine the acceleration, the tractive force, and the running resistance to which trains are subjected. This will be followed by some interesting particulars about the 'Liverpool and Manchester Electric High Speed Railway,' contributed by Sir William Preece. Mr. Gibbings will deal with 'The Design and Location of Electric Generating Stations' on a large scale for supplying electric power and lighting to large districts, and Mr. Barker will describe 'A Maximum Demand Meter,' the joint invention of himself and Professor Ewing. Tuesday, the last day on which the section meets, will begin with a paper by Mr. J. G. W. Aldridge, entitled 'The Automobile for Electric Street Traction.' It is hoped that the cinematograph will be used—for the first time, it is believed, at a British Association meeting—to illustrate this paper, which will deal with an actual service in operation in Paris, and will show how, under certain conditions, a tramway service may be organized without the usual tramway lines. Professor Goodman will describe 'A New Form of Corimeter for measuring the Wetness of Steam,' which he has himself invented. Two other papers are of considerable importance. In the first, Professor Arnold of Sheffield, will deal with what he terms 'the internal architecture of steel,' and will develop his theories on the ultimate molecular structure of steel and the micrographic analysis of steel in physical researches. The second, by Mr. E. K. Clark, of the firm of Messrs. Kitson & Co., will deal, under the title of 'Shop Buildings,' with modern engineering, workshop buildings, and methods of laying them out and organizing the work in them.

Professor John Rhys, who will preside over Section H (Anthropology), will probably deal in his address with the early ethnology of the British Isles, approaching the subject from the sides of language and folklore. It is hoped that other contributions to this subject, which are anticipated, may give opportunities of discussing some of the vexed questions which it includes. A discussion is also proposed on the subject of 'Animal-cults: their Relation to Totemism,' which has been variously interpreted of late years; and on the present state of our knowledge of the origin of writing in the Mediterranean. Mr. Arthur Evans will describe the pictographic system of writing of which he has disinterred numerous specimens at Knossos in Crete; and Mr. F. Griffith offers a paper on the development of Egyptian hieroglyphics. Dr. Haddon will describe the results of the recent Cambridge expedition to Sarawak; and Mr. David Boyle, of Toronto, has a paper on recent revivals of native religious beliefs among the aboriginal tribes of Canada. Professor Cunningham, Dr. Beddoe and Professor A. F. Dixon send papers dealing with questions of anthropometry.

Professor Sydney H. Vines will preside over the Botanical Section (J). His address will deal with Botany in the 19th century, and will be a review of the more important advances made in the different departments of the science. As has already been stated, this Section will have a joint discussion with the Geological Section on the Coal Period Vegetation. A museum is being arranged to illustrate the Yorkshire Coal Measure Flora, etc., in connection with the discussion. Mr. Percy Groom, of Coopers Hill Engineering College, is to deliver a semi-popular lecture before the Section entitled 'Plant-form in Relation to Nutrition.' There will also be papers on Fossil Plants, Plant Anatomy, Plant Physiology, etc.

The Friday evening discourse will be delivered by Professor Gotch, the subject being Animal Electricity, while that on Monday evening will be by Professor W. Stroud, whose subject will be 'Range Finders.' Professor Sylvanus P. Thompson will give the lecture to the operative classes on Saturday, and will take as his subject 'Electricity in the Industries.'

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*VARIATION AMONG HYDROMEDUSÆ.**

THE announcement of Bateson in his 'Materials for the Study of Variation' that medusæ best illustrated the principle which he designated as 'Discontinuity of Meristic Variation' led me, in connection with researches which have been under way for several years, to note more specially any indications which might either confirm or discredit this statement. Accordingly I have from time to time made such collections of the Hydromedusæ as might afford a means of testing the matter. While as yet these have not been extensive, except in a few genera, they seem to be sufficient to warrant a brief summary of facts bearing upon the general problem of variation. The collections have been chiefly of the following genera: *Eucope*, *Obelia*, *Margelis*, *Pennaria* and *Gonionemus*.

The facts exhibited by *Eucope* have recently been published by Agassiz and Woodworth, and while I have made observations upon those which I had collected in larger numbers than any other, they are yet so similar to those made by these observers that I shall make no particular reference to them at this time. Of the species of *Obelia* and *Margelis* I have as yet had no opportunity for extended study. Facts presented here will have reference only to the species of *Pennaria* and *Gonionemus*.

Of *Pennaria* the medusæ are very small and of a shape which renders rather difficult an examination of the radial canals, a feature which, in my observations, has been among the most variable of structural characters. From the examination of only about a hundred specimens I have found no marked variation of this feature except in the direction of atrophy. The medusa of *Pennaria* seems to be in a somewhat degenerate condition. In many specimens the marginal canal is wholly atrophied and in some cases also the radials, to a greater or less extent. I have elsewhere* pointed out that in many cases the medusæ of this species never become free, but discharge the generative products while remaining connected with the polyp. Another feature which may prove to be a variation is the appearance of small wart-like or vesicular protuberances at various points of the exumbrella. Agassiz, in the North American *Acalephæ*, refers to a similar feature but explains it as probably due to the distortion caused by ova in the subumbrellar cavity. This, however, I am strongly convinced is

* Abstract of a paper presented before the Section of Zoology of the American Association.

**Am. Nat.*, May, 1900.

a mistaken view, for the vesicles remain after the eggs have been discharged, and are quite as prominent in preserved specimens as in those alive and bearing eggs. As to variation in tentacles there seems to have been little. These organs are so rudimentary that detection of variations in them would be extremely difficult.

Upon the whole this species seems to be fairly constant in general structural features and only in the deeper and microscopic aspects are signs of degenerative variation specially apparent. The variation in physiological habits to which reference has been made are, however, very marked and of quite as much significance as are those more conspicuous morphological features usually cited. I would offer this suggestion that in those cases in which the medusæ perish early after discharging the ova, and specially those which do not become free at all, there may be some correlation between the atrophy of the chymiferous canals and this shortlived condition.

It is among the species of *Gonionemus* that I have discovered the most notable and numerous variations. Of these more than five hundred specimens were examined, all of which were taken at Woods Holl during the summers of 1897-99. Attention was directed chiefly to a study of the gonads, radial canals and tentacles. Of the specimens examined only fifteen showed abnormal or unusual genital features. In five specimens the gonads were atrophied upon one of the radial canals and equally developed upon the others. One specimen showed the gonads developed only upon one of the canals. Six specimens showed no trace whatever of gonads though they were of full size and normal in every other respect. Another specimen showed only traces of gonads as two small knobs near the bases of two approximate canals.

There was considerable variation in both the number and arrangement of tentacles. In reference to variation with age it was found that on the smallest specimen examined measuring two mm. in diameter the tentacles were twenty-nine, while on the largest 19 mm. in diameter there were 68 tentacles. The number, however, was not always proportional to the size. For example, one specimen of 4 mm. diameter had 39 tentacles, while another of 6 mm. had but 30 ; the largest referred to above had 68, while a specimen but 14 mm. in diameter had 71, and two others of 15 and 16 mm. had 72 each. In only 11 of the 500 specimens were the number of tentacles between each radical canal equal and symmetrical. In the order of appearance of new tentacles there did not seem to be any definite regularity. For example the following from many observations may reveal this more clearly :

(1) 2–1, 2–1, 2–1, etc. (2) 7–1, 3–1, 7–1, 3–1, etc. (3) 11–1, 11–1, 11–1, etc. In each case the 1 indicating the new tentacle.

In only a single specimen was there found any bifurcation of the tentacles which was so conspicuous a feature in *Eucope*. In this specimen there were two tentacles arising from a single sensory bulb and two others showed bifurcation, one near the tip, the other near the base.

In the number and character of the radial canals there was the most marked exhibition of variation. In number the variation was from two to six. Of the minimal number, two, only a single specimen was found, but it was in every way normal other than this, and the correlated fact that there were but two gonads. These canals were continuous and divided the body into halves.

Of specimens with six canals several were found, some of which clearly showed the canals converging symmetrically to the gastric pouch, but in a few cases the extra two canals were found to result from an apparent bifurcation of two of the primary canals at distances varying from a fourth to three-fourths of the distance toward the margins.

Several specimens were likewise found with five canals. Indeed, this was a not uncommon feature and the medusa was divided into a regular pentamerous form, quite similar to reports made by several observers of pentamerous Aurelias.

Of those with three canals several varieties were found, those with three symmetrical canals dividing the bell into thirds, or making a trimerous form, the canals being at angles of 120 degrees. In other cases the one-half of the bell was equally divided by the third canal into quadrants while the other half remained undivided, showing that in this case there had been the total suppression of one of the canals.

In a few cases a sort of aboral circular canal was present, the radials instead of entering directly into the gastric pouch entered a circular canal which surrounded it. Of these there were several forms which only diagrams can make clear.

In conclusion it may be suggested that there was an apparent absence of any correlation of variation and also of any 'meristic' feature.

Charles W. Hargitt.
Syracuse University.

LATERAL LINE ORGANS IN EUNICE AURICULATA n. sp.

In a hitherto undescribed species of *Eunice*, to which I have given the above specific name, occurs a lateral line organ which, so far as I can learn, has not previously been discovered in this family. The specimens were collected in Porto Rico by the U. S. Fish Commission Steamer *Fish Hawk* during the winter of 1898–99.

The parapodium, as is characteristic of this genus, is uniramous, only the notopodium remaining, *not*, Fig. 1. Dorsally this carries a long cirrus *d. c.*, and a gill *gill* attached to this cirrus. These gills are absent from the most anterior segments and appear first on the parapodia of the 19th segment. The parapodium carries a single

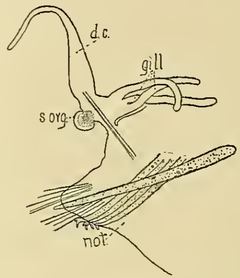

Fig. 1.

stout, straight, aciculum, with several smaller ones, toothed at the ends, and crossing the first at an angle. A dorsal and a ventral bundle of fine setæ are present. Anteriorly there is a thick ventral cirrus, which is much smaller toward the posterior end of the body (not shown in the figure.) A bundle of fine setæ extends into the dorsal cirrus.

The organ in question is situated on the outer side of the base of the dorsal cirrus, *s. org.*, Fig. 1. It appears on the first segment as a slight swelling, which becomes more

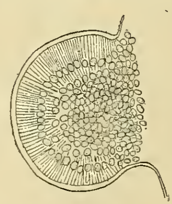

Fig. 2.

and more prominent posteriorly, until it reaches the condition shown in fig. 1. It is a rounded, smooth projection, slightly constricted at the base, and in preserved material, showing no trace of pigment.

Examination of stained specimens shows that they apparently have the structure of the lateral line organs described by Eisig for the Capitellidæ.* There is the same arrangement of the nuclei, and the same radiations extending from the center toward the periphery (Fig. 2). No trace of cilia could be seen on preserved material, and the organ is apparently not capable of retraction into special sacks in the body wall. The cuticle, also, is relatively more thickened on the outside of the organ than is represented by Eisig's figures.

I am unable to give any details of the finer anatomy of these organs. The material at my disposal is not well enough preserved for histological study, and macerations and sections have thus far yielded no results. My only excuse for presenting this incomplete note is that while it is desirable that the existence of the organ in the group should be noted, there seems no probability of securing more favorable material.

Aaron L. Treadwell.
Marine Biological Laboratory,
Woods Holl, Aug. 10, 1900.

* 'Fauna und Flora Golfes v. Neapel' 16, p. 76, *et seq.*

SCIENTIFIC BOOKS.

An Outline of the Theory of Thermodynamics. By Edgar Buckingham, Ph.D. (Leipzig), Associate Professor of Physics and Physical Chemistry in Bryn Mawr College. New York, The Macmillan Co.; London, Macmillan and Co., Limited. 1900. 14 x 22 cm. Pp. xi + 205.

In the preface of this newest book on thermodynamic theory, the author states his aim in the following words: "In the course of studying thermodynamics I have found a considerable gap between the text-books available and the modern memoirs. This volume has been written to spare other students some of the time which I have had to spend in bridging over the gap for myself. As the title indicates, it is not a book of applications, but a brief outline of the theory, the applications having been selected solely with a view to their illustrative value." The book is evidently intended for the beginning student.

The treatment begins with the necessary introductory concepts, then takes up successively the first and the second laws of thermodynamics, and concludes with a discussion of the criteria of thermodynamic equilibrium, and of the phase rule.

Under the first of these general heads appears a lucid and brief chapter on thermometry, an elaborate analysis of the idea of a quantity of heat, and the statement that only systems that have equations of equilibrium are to be considered. It is not emphasized, as it might well have been, that a quantity of heat is a purely auxiliary quantity, a convenient but wholly arbitrary mathematical fiction. In connection with the first law of thermodynamics, we find a simple discussion of the law, an exposition of the law of constant heat sums and of the relation between heat of reaction and temperature, and a study of specific heats. A recapitulation at this point completes the first half of the book.

Passing to the second law of thermodynamics, we are introduced to: reversible processes and Carnot's theorem; the ideas of absolute temperature and of entropy, derived from the properties of ideal gases; the combination of the two laws, to yield the differential of the energy of a system; and Gibbs's fundamental equations, which result from changing the independent variables. This part of the book is completed by an admirably clear and consistent account of the theory of the porous-plug experiment, and a number of simple illustrative applications of the general theory. The final three chapters are devoted mainly to the criteria of thermodynamic equilibrium, and to the phase rule as applied to systems in which no chemical combination occurs. It is not made clear here that the criteria of equilibrium are consequences of the inductively reached principle of the spontaneous dissipation of work availability.

In all this, Professor Buckingham has done pretty satisfactorily what he set out to do. The subject-matter is well arranged; the book is brief, as it should be for the beginner; and the details of the treatment have been carefully thought out and clearly written. The result is probably as satisfactory a student's text as we have.

But a general comment in conclusion seems to be called for. Many people like to have their thermodynamics developed as a sort of sub-topic of the theory of ideal gases. They appear to think it suitable that one of the most beautiful and wide-reaching branches of physical theory should be developed largely from the properties of bodies that exist only in the imagination. In the reviewer's opinion, this procedure is neither necessary nor wise. There are two ways in which an exposition of theoretical thermodynamics can be written. One can reach the absolute temperature and the entropy from the properties of ideal gases, as Professor Buckingham has done; or he can arrive at these functions from fundamental physical postulates. The latter method reaches true results from true premises; while the former jumps to true results from untrue premises. The latter method, properly worked out, is fully as easy of comprehension as the former; and it gives a broader view: for it parallelizes the thermodynamic temperature with other potentials, and the entropy with other quantity-co-ordinates; and it brings out the distinction between forces and potentials, and between spaces and quantity-co-ordinates. As a plain matter of fact, the theory of thermodynamics of the present day is a symmetrical mathematical analysis of the general problem presented by a small number of inductively established postulates; and, in consequence, it cannot be grasped until it is comprehended as a logical system of mathematically developed theory.

J. E. TREVOR.

Microörganisms and Fermentation. By ALFRED JORGENSEN. Third edition. Translated by ALEX. K. MILLER and A. E. LENNHOLZ. The Macmillan Co. Pp. 318.

A practical knowledge of the phenomena of fermentation has been possessed by man from time immemorable. Until the present century, however, this knowledge has been purely an empirical one, the real cause of the phenomenon not being suspected. The present century has seen the development of the subject from a scientific standpoint, until to-day our knowledge of the process of fermentation is thoroughly systematic and based upon accurate experimentation. The development of our present knowledge upon the subject is properly divided into three periods. The first was that of the indefinite work of the early decades of the century, when Schwann and others were demonstrating that fermentative processes were closely related to the life activity of microörganisms. The second period was dominated by the revolutionary work of Pasteur. Under his influence not only was it demonstrated that fermentations were caused by microörganisms, but various types of fermentation were recognized and found to be produced by different species of microörganisms. Under Pasteur's influence the microscope came to be an aid to the fermentative industries and many a valuable practical method was suggested and applied to the fermentative processes. The third period has been the most fruitful in results and in many respects the most important. This period has been dominated by Hansen, of Copenhagen. So valuable has the work of Hansen been to the brewing industry that a large brewery of Copenhagen has erected for his use one of the best equipped laboratories in Europe, designed both for practical experiments and for pure scientific investigation. This third period of discovery has been dominated by the invention of methods of procuring *absolutely pure cultures* of yeasts.

There is no one better able to write an account of the relation of microörganisms to fermentation than the author of this work, who lives in close relation to Professor Hansen, and if his presentation of the subject is possibly unduly influenced by Hansen's work it is not to be wondered at. The fact is that the whole subject of fermentation has been entirely changed in the last two decades as a result of the study of the strictly pure cultures obtained by Hansen's methods. The earlier theories of fermentation have given place to the theory that fermentations are the results of enzymes produced by microörganisms. The knowledge of the yeast organism has been completely changed as the result of the study of pure cultures. The few species known to Pasteur have become many and distinct in the hands of modern students. The diseases peculiar to fermentated products, attributed by Pasteur to bacteria, have been found to be frequently due to yeasts which are present as impurities, and the whole method of conducting fermentations in the great breweries has been modified in consequence. All these facts are brought out in more or less detail in this work of Jorgensen, who shows on every page of his writing a knowledge of the facts at first hand.

The whole work is not confined to the fermentations produced by yeasts. The growing knowledge of the significance of bacteria in fermentations has demanded attention, and the more important species of moulds are not overlooked. The treatment of this side of the subject is much less satisfactory than the study of yeasts. In his discussion of the butyric fermentation, the lactic fermentation and other strictly bacteriological phenomena Professor Jorgensen is evidently not so much at home as when he is writing of yeasts.

The most valuable part of the work is, therefore, the review of our present knowledge of yeasts. He describes the methods of studying air and water; the most recent methods of obtaining absolutely pure cultures of yeasts, the methods of cultivating them and experimenting with them. A considerable part of the work is taken up by a description and by figures of the many species of yeasts which have been differentiated from each other by modern study. Their methods of forming spores, of germinating, of forming films, and, in short, all of the characters of yeasts which are used today by the specialists in describing yeasts are carefully and fully discussed. As a morphological and physiological study of this extremely important group of plants the present work is complete and unequaled. Certainly there is no work in English that contains such a comprehensive account of the modern knowledge of yeasts and their relation to fermentation.

The name of The Macmillan Company on the title page is a sufficient guarantee of the excellence of the press work, as the name of the author is a guarantee for its scientific accuracy. It seems strange, however, that the author, the translators and the publishers should have allowed such a book to be published without an index. A book of this sort may perhaps be designed for consecutive reading, but it will be much more commonly used as a book of reference. As a book of reference its value would be doubled by the presence of a good index. No excuse can be given in these days of many books for omitting such an indispensable part as an index. The lack of the index is in part made up by a magnificent bibliography containing references to all the important works bearing directly or indirectly upon the problems of fermentation. This will be to the student perhaps the most useful part of the whole work.

H. W. C.

BOOKS RECEIVED.

Air, Water and Food from a Sanitary Standpoint. Ellen H. Richards and Alpheus G. Woodman. New York, John Wiley & Sons; London, Chapman and Hall, Limited. 1900. Pp. iv + 226. $2.00.

Prehistoric Implements. Warren K. Moorehead. Cincinnati, The Robert Clarke Co. 1900. Pp. xv + 429.

Die Chemie in täglichen Leben. Lassar-Cohn. Fourth edition. Hamburg and Leipzig, Leopold Voss. 1900. Pp. viii + 320. 4 Mark.

A Brief Course in General Physics, Experimental and Applied. George A. Hoadley. New York, The American Book Company. 1900. Pp. 463. $1.20.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, April. 'A Preliminary Investigation of the Conditions which determine the Stability of Irreversible Hydrosols,' by W. B. Hardy; 'On the Mechanism of Gelation in Irreversible Systems,' by W. B. Hardy; 'Isohydric Solutions,' by W. D. Bancroft; 'Vapor-pressure Relations in Mixtures of Two Liquids,' by A. E. Taylor; 'In Reply to a Statement made by Dr. R. Cohen in a Paper on the Theory of the Transition Cell of the Third Kind,' by H. T. Barnes.

May. 'On the Weston Cell as a Transition Cell and as a Standard of Electromotive Force, with a Determination of the Ratio to the Clark Cell,' by H. T. Barnes; 'On the Electrolytic Deposition of Metals from Non-Aqueous Solutions,' by Louis Kahlenberg—Faraday's law was found to hold approximately in such solutions; 'Vapor-pressure Relations in Mixtures of Two Liquids, II,' by A. E. Taylor; 'On the Determination of Transition Temperatures,' by H. M. Dawson and P. Williams; 'The Driving Tendency of Physico-Chemical Reaction, and its Temperature Coefficient,' by T. W. Richards.

June. 'The Allotropic Forms of Selenium,' by A. P. Saunders—an exhaustive contribution to an illy investigated subject. The author finds that selenium exists in three distinct forms:

1. Liquid (including vitreous, amorphous, and soluble selenium).

2. Crystalline red (including perhaps two closely allied forms).

3. Crystalline gray or metallic.

'An Exposition of the Entropy Theory,' by J. E. Trevor; 'Entropy and Heat-Capacity,' by J. E. Trevor; 'The Relation of the Taste of Acid Salts to their Degree of Dissociation, II,' by Louis Kahlenberg—showing that the theory of electrolytic dissociation does not satisfactorily account for the phenomena connected with the sour taste of acid salts of weak acids. A rejoinder to the work of T. W. Richards and of A. A. Noyes.

DISCUSSION AND CORRESPONDENCE.

EMINENT AMERICAN MEN OF SCIENCE.

To the Editor of Science: In Science of August 17th I notice the names of about twenty eminent Americans proposed as suitable to be engraved in the Hall of Fame of the New York University and also your question as to how many men of science should be included, and who they should be. In response to the query I beg respectfully to suggest the following names: Professor O. C. Marsh, Professor E. D. Cope, Dr. James Hall, Dr. D. G. Brinton, Professor J. D. Dana, Professor Newberry, Professor Orton, and Professor Alexander Winchell, in addition to those already mentioned. I do not see how these eight names could be omitted from such a list, nor do I see how the names of Henry, Silliman, Torrey, Gray, Hitchcock, and Baird could be left out. I should think that at least thirty men of science should be included among the one hundred.

Henry Montgomery.

Trinity University, Toronto,
August 20, 1900.

INTERNATIONAL COMMISSION ON ATOMIC WEIGHTS.

Science for August 17th contained a resumé of the report of the committee of the German Chemical Society, giving the views of the International Commission on Atomic Weights. On the chief point at issue, the selection of a standard for atomic weights, with the exception of six German members and one American (Professor Mallet), the commission was unanimous for oxygen = 16. This point, at least, would have seemed settled, but the German minority have in the last *Chemical News* reopened the question. The essence of their argument for H = 1 is comprised in the following paragraph:

"For the teacher, simplicity and clearness of the foundation seem specially important; instruction must suffer no harm with regard to the enlightening construction of the law of volumes, no shadow of doubt must penetrate the doctrine of valency. Regard for the understanding of prospective chemists will compel us therefore, under all circumstances, in teaching and in our text-books, to retain Dalton's numbers, and Professor F. W. Clarke, the worthy editor of the Annual Atomic Weight Tables of the American Chemical Society, authorizes us to say that he recommends the retaining of the standard H = 1. For if numbers were used in practice which were unsuitable to use in teaching, confusion would be the natural consequence, instead of the unanimity desired by all."

The German minority therefore calls upon all teachers of chemistry in universities and technical high schools to take a definite position in regard to this matter, and to send their answers to the subjoined questions to Professor J. Volhard, Halle-a-S., Mühlpforte 1, at their earliest convenience. The editor of the *Chemical News* also desires to publish copies of these replies. The questions are as follows:

1. Shall the unity of hydrogen be retained as the standard for reckoning atomic weights?

2. Shall the atomic weights be given approximately with two decimal places in which the

uncertain figures can be recognized by the type?

3. Shall the International Atomic Weight Commission have the current table of atomic weights edited on this basis?

In comment it may be mentioned that not all teachers are troubled by using O = 16 as a standard, and that there is a very large body of chemists outside the ranks of teachers, to whom this standard offers the decided advantage, that with this a large share of the more commonly used atomic weights approximate very closely to whole numbers. J. L. H.

PLANT EMBRYO-SACS.

SOME recent studies by the writer on the young ovules of the lily-of-the-valley, pond-weed (Potamogeton), and the garden canna have shown a number of interesting features in connection with the development of the embryo-sac. The first division of the nucleus in the hypodermal cell is heterotypic, while the next two represent the 'reducing division'; hence in these plants this cell strongly suggests the pollen-mother-cell of the anther. Apparent reduction takes place as usual just previous to the heterotypic division. The reduced number of chromosomes in the lily-of-the-valley was eighteen, in pond-weed about eight, while in canna it was only three, one of the smallest yet recorded for plants. In the lily-of-the-valley and pond-weed only the heterotypic division is followed by a cell wall, thus resulting in an 'axial row' of two binucleated cells; in canna all three divisions produce transverse walls and the axial row is therefore four celled. In the first named plant both cells enter into the formation of the embryo-sac, in pond-weed the lower only, while in canna only the lowermost of the row of four. Therefore in lily-of-the-valley the embryo-sac contains all four nuclear elements from the mother cell as in *Lilium*, in pond-weed only two, and in canna only one. Can the embryo-sacs in these cases be homologous structures, and should a macrospore contain more than one of these nuclear elements? In pond-weed a membraneous pouch formed around the egg-apparatus at a very early period seems to preclude entirely the fusion of polar nuclei to form the endosperm mother nucleus. In this plant also the chromatin is aggregated into a central ball during the resting stage as in some animal tissue. Those interested in the details of the work may find a fuller account in the *Botanical Gazette* for July of this year.

K. M. WIEGAND.

SCIENTIFIC NOTES AND NEWS.

THE monument of Lavoisier, erected by international subscription, was unveiled at Paris on July 27th. There were present the members of the fourth International Congress of Chemistry and a large number of scientific and public men. M. Berthelot who was to have presided was unable to be present on account of ill health, and his address was read by M. Darboux. The monument was presented to the city of Paris by M. Moissan, to whom M. Leygues, the minister of public instruction, responded.

FAIRMAN ROGERS, formerly professor of civil engineering in the University of Pennsylvania and one of the original members of the National Academy of Sciences, died in Vienna on August 21st. He was born in Philadelphia in 1833, graduated from the University of Pennsylvania and was professor of civil engineering in that institution from 1855 to 1870. From 1853 to 1865 he was also lecturer on mechanics in the Franklin Institute. On retiring from the professorship in the University of Pennsylvania he became a trustee, and gave later to the institution his valuable collection of works on engineering. Mr. Rogers served as an engineering officer in the civil war and was connected with the Coast and Geodetic Survey. He was the auther of 'The Magnetism of Iron Vessels' and of numerous papers on scientific and engineering topics. Mr. Rogers was formerly prominent in Philadelphia and New York society, but has latterly lived abroad.

THE Paris 'Conference Scientia' has given a banquet to Lord Lister and will later entertain in a similar manner Lord Kelvin.

M. DUHEM has been elected a correspondent of the Paris Academy for the section of mechanics.

DR. AUGUST LEPPLA has been appointed State geologist and Dr. Oskar Zeise district geologist in the Geological Institute at Berlin.

Dr. Karl Stöckl, of the University of Tübingen, has been appointed assistant in the Meteorological Institute at Munich.

Captain George Eldridge, a hydrographer, died on August 23d at Chatham, Mass., aged 72 years. He was the author of a book on the tides and completed valuable charts of the coast from Chesapeake Bay to Belle Isle. In later years he made charts of the waters along the coast as far south as Florida.

Sir William Stokes, the eminent Irish surgeon, died on August 19th at Durban, having gone to South Africa as consulting surgeon to the British forces. He was born in Dublin in 1839, being the son of Dr. William Stokes, regius professor of medicine in the University of Dublin.

The death is announced of Dr. August v. Strombeck, the geologist, in Braunschweig, at the age of 92 years.

A monument in honor of Pelletier and Caventou, the chemists, to whom the discovery of quinine is due, was unveiled at Paris on August 7th. An address was made by M. Moissan, president of the committee, who presented the monument of the city of Paris and by other speakers. There were a large number of pharmacologists present, as the dedication occurred at the time of the meeting of the Ninth International Congress of Pharmacology. The statue is by the sculptor, M. Lormier, and is on the Boulevard Saint Michel.

The Peabody Academy of Science at Salem, Mass., is trying to raise $50,000 for an addition to the Museum building. Already over $26,000 has been pledged for the purpose.

The New York Botanical Gardens at Bronx Park have received a valuable collection of plants from Miss Helen Gould.

More than 900 geologists have become members of the International Congress now meeting at Paris. It appears that four subjects will be brought forward for special discussion : international co-operation in geology, by Sir A. Geikie; the establishment of definite classifications, by T. C. Chamberlin ; the publication of a petrographic lexicon by a committee on the subject, and the republication by photography of types of fossil species by Professors Œhrert and Kilian. Over 400 geologists will take part in the twenty-five excursions that have been arranged. A guide, 1000 pages in extent with numerous figures and plates, has been compiled by the leading French geologists.

Dr. W. H. Wiley has sent a notice to the effect that in harmony with the vote of the executive committee, the seventeenth annual meeting of the Association of Official Agricultural Chemists will be held in Washington, D. C., beginning Friday, November 16th, and continuing over Saturday and Monday, 17th and 19th, or until the business of the Association is completed. The authorities of Columbian University have extended the courtesy of the use of the University lecture hall for the various sessions. The following order of business will be observed : The president's address ; reports of the referees in the following order : on nitrogen, on potash, on phosphoric acid, on soils, on ash, on foods and feeding stuffs, on liquor and food adulteration, on dairy products, on sugar, on tannin, on insecticides ; reports of special committees (abstract committee, food standards, fertilizer legislation, volumetric standards).

A society with 400 members has been organized in Switzerland to study questions of school hygiene. Its first meeting has been held recently in Zurich under the presidency of Dr. Schmid, director of public hygiene. The next meeting will be at Lausanne.

The *Electrical World* reports that a conference in New Haven has been called by Mayor Cornelius T. Driscoll, and Director Alexander Troup, of the Department of Public Works, in order to devise means of saving the old elms of the city. The prolonged drought has accentuated the evidences of general decay, and the city government has at last awakened to the necessity of action. The State Agricultural Experiment Station has for several weeks been at work on the matter. An expert from there, Dr. A. B. Jenkins, will, at a general conference of citizens, to be held shortly, give the result of his observations. The officers of the street Electric Railroads, Electric Light Company and the Gas Distributing Company, have been invited as a body, and personal letters to leading citizens have gone out from the mayor's office asking them to be present. Is it permanent pavements, or leakage from gas mains, or induction currents from the trolley wires, or the elm-tree beetle that killed the elms? these are the propositions to be discussed. In view of the fact that one-third of the elms on the Central Green are dead or dying, the matter is of great importance.

THE San José scale has appeared in Brooklyn in many places, and it is feared that the insects may do much damage to fruit and shade trees.

THE three surviving buffaloes of the Cheyenne River herd have been sent to Chicago, where they will be sold and perhaps slaughtered. It will be remembered that an attempt was made to continue the herd at Pierre, S. D., but without success.

THE government of Chile has assigned a sum of $20,000 to the president of the National Society of Agriculture to enable him to purchase agricultural machinery in foreign markets and sell it at cost price to members of the Society.

A REUTER telegram from Liverpool says: The second malarial expedition of the Liverpool School of Tropical Medicine has just wired home from Bonny, in Nigeria, news of a most important discovery, viz, that the parasite which causes elephantiasis has, like that which causes malaria, been found in the proboscis of the mosquito. Oddly enough, the same discovery has just been simultaneously made by Dr. Low in England in mosquitoes brought from Australia, and by Captain James in India. Elephantiasis is a disease which causes hideous deformity in thousands, or rather millions, of natives in tropical countries, and sometimes in European residents. It is due to a small worm which lives in the lymphatic vessels and occludes them. The fact that this worm can live also in the mosquito has long been known, but the discovery of it in the insect's proboscis shows that it enters the human body by the bites of these pests. Europeans in the tropics are indebted to mosquitoes not only for much discomfort but for two dreadful maladies—malaria and elephantiasis; and it is high time that the authorities should begin seriously to consider Major Ross's advice to destroy these insects or their breeding-places wherever practicable.

DURING the present summer Professor F. E. Nipher, of Washington University, has been working on his methods of developing positive photographs in the light. The work has been done in the rooms of Professor Calvin. He finds that as the camera exposure is made shorter, the developing band must be more strongly illuminated. He is now developing clear pictures, with no trace of fog when the bath is placed in the direct sunlight, but covered by transparent color screens. Good results have been obtained with ruby, and with pure yellow screens. The screens are made by fixing an unused photographic plate, and after drying the gelatin film, the plate is put in a water solution of red or yellow analine.

IT is said that the returns of the census indicate a population of the United States of about 75,000,000. The cities already counted show the following results, the returns for this year being placed beside those of 1890, with the percentage of increase:

Cities.	1900.	1890.	Percentage of increase.
Greater New York...	3,437,202	2,492,591	37.90
Chicago	1,698,575	1,099,850	54.44
Philadelphia	1,293,697	1,046,964	23.57
Cleveland..........	381,768	261,355	46.07
Buffalo	352,219	255,664	37.77
Cincinnati.........	325,902	296,908	9.77
Milwaukee.........	285,315	204,486	39.54
Washington........	278,718	230,392	20.98
Jersey City.........	206,433	163,003	26.64
Louisville..........	204,731	161,129	27.06
Minneapolis........	202,718	164,738	23.05
Providence.........	175,597	132,146	32.88
St. Paul............	163,632	133,156	22.89
Toledo.............	131,822	81,434	61.88
Columbus..........	125,560	88,150	42.44
Omaha.............	102,555	140,425	—26.98
Hoboken	59,364	43,648	36.01

THE fifth part of Professor William H. Dall's important work on the *Tertiary Fauna of Florida*, forming the fifth part of Vol. III. of the Transactions of the Wagner Free Institute of Science, will probably appear in September.

MESSRS. HENRY HOLT & Co.'s preliminary fall announcement includes 'An Agricultural Botany' (theoretical and practical), by Professor

John Percival, of the Southeastern Agricultural College of Wye, England, intended for practical farmers who have made no systematic study of botany; 'The Anatomy of the Cat,' by Professor Jacob E. Reighard and Dr. Herbert S. Jennings, both of the University of Michigan; 'A Manual of the Flora of the Northern States and Canada,' by Professor N. L. Britton, director of the New York Botanical Garden; 'Schenck and Gürber's Human Physiology,' translated by W. D. Zoethout, with a preface by Professor Jaques Loeb, of the University of Chicago. The same publishers report that Professor James's 'Talks to Teachers on Psychology' has gone to press for the eighth time.

At the anniversary meeting of the Royal Botanic Society, London, the chairman, in moving the adoption of the 61st annual report of the council, referred to the death of the Duke of Teck, who had been president of the Society for more than 30 years. The presidency had since been offered by the council to the Duke of York, who had been obliged to decline. It has been offered to the present Duke of Teck, who is now in South Africa. The report stated that the number of new Fellows and members elected during the year had been 203, and there was now a total of 2205 fellows and members. The Royal Botanic Gardens Club had progressed in a very satisfactory manner, and the number of members was now 570. The School of Practical Gardening had been increased in number by the addition of ten more scholars from the London County Council Technical Education Board, and the Middlesex County Council had signified their intention of giving three scholarships. The Earl of Aberdeen and Viscount Curzon, M.P., were elected into the council.

The Annual Congress of the British Royal Institution of Public Health opened in Aberdeen on August 2d, with about 800 members in attendance. In the course of his presidential address, Lord Aberdeen reviewed the progress of sanitation, especially as represented by legislation upon the subject. He remarked, according to the report in the *London Times*, that it was exactly 100 years ago since the first enactments were passed which could be described as the direct ancestry of modern sanitary legislation. The earlier Factory Acts, designed especially for the protection of the children, who were often herded together promiscuously within the actual factory buildings, might come under this category. Another kind of legislation which advanced concurrently took its origin in the necessity which had to be faced in crowded communities for an organized supply of water as distinguished from independent and casual pumps and wells. So, too, with sewerage. The measures dealing with these elementary needs were the parents of our local sanitary Acts as distinguished from the factory class of legislation which had throughout been administered under the authority of the Home Office. It would be difficult to over-estimate the importance of the new kind of administration as a whole, not merely in regard to its direct remedial operations, but as to its indirect and suggestive influence in education and enlightenment as to health arrangements. There had been a great and growing advance in sanitation, but, reviewing the whole position, there was no cause for complacency. Contemplation of what had been accomplished, however, often in spite of prejudice and many obstacles, might assuredly give ground for encouragement and confidence as to future progress and attainment resulting from careful and persevering effort in dealing with the problems which still confronted sanitarians. Amongst these was overcrowding, and from every point of view—religious, moral, and humanitarian—there was crying need for the alleviation of that evil. Happily, public attention was being increasingly drawn to the subject, and a certain amount of reform had been attempted, but they must feel that the subject had yet to be grappled with in all its complexity and magnitude. Another field of sanitary reform was in relation to consumption, regarding which they seemed to have reached an epochal stage. That it was a subject for prevention and control was a revelation, and the main course of action would have to be that of educative regulation.

It is announced in the *British Medical Journal* that the Liverpool School of Tropical Medicine recently heard from the expedition it has sent to West Africa and America. Drs. Annett, Elliott and Dutton report from Bonny that they have visited Opobo, Slave, Trees, Bakana, Bugana, Degama, Abonnema and Egwanga. They intended to revisit the latter place to complete some experiments there initiated, and then proceed up the Niger as far as Lokoja. The expedition under Drs. Durham and Myer received a cordial welcome from the authorities at Washington and Baltimore, and at the special wish of Dr. Sternberg, Surgeon-General of the United States Army, has gone to Cuba with the American government expedition to study yellow fever in Havana. The Brazilian government is preparing to receive the expedition at the end of this month. A letter has been received at the Liverpool School of Tropical Medicine from Dr. J. Paes de Cavalho, Governor of the State of Para, in reference to the expedition to study yellow fever. He writes: "Appreciating the high and scientific value of the Liverpool School I hereby anticipate my thanks for the valuable services that scientific institution will render to Para, to Brazil, and, in fact, to humanity, thus contributing to the study of a disease which, unfortunately, has become endemic in some Brazilian ports, and every year destroys hundreds of precious existences, carrying discredit to our country and harming our progress. To such a mission I most gladly pledge this government's assistance and co-operation, which I consider due to the noble intention of the said society. The State of Para will do its utmost to receive them with honor."

PROFESSOR E. RAY LANKESTER, director of the British Museum (Natural History), has addressed the following letter to the *Times:* Now that our army is guarding, for the most part peaceably, a line 1000 miles long from Cape Town to Pretoria, and that many of its members may be in want of occupation to fill their time, may I suggest that the opportunity might be taken to help our National Museum to obtain series of specimens illustrating the fauna and flora of the country? Even of the larger animals many of the commonest are still *desiderata* to our collections, while of the smaller things, from meerkats to mosquitoes, from squirrels and stoats to snakes and snails, there are none, however common locally, of which sets would not be of value and interest to our specific workers. It should be remembered that for the study of variation, individuals, seasonal and geographical, large series are wanted from as many different places as possible, so that no one, say, at Colesberg or De Aar, need think that his specimens will not be appreciated because some one else at Bloemfontein or Kroonstad is also sending specimens supposed to be of the same sort. Especially all the 'game' animals are wanted, from antelopes to smaller buck of different sorts (steenbok, grysbok, etc.), hares, rock rabbits, and other things that our officers appear to be now frequently shooting. Also such 'vermin' as jackals, hyenas, monkeys, baboons, etc. Skins and skulls of all these, marked with locality, date, and a clear indication of which skull belongs to which skin, would be most acceptable. And the same with the smaller animals. I shall be glad to hear from persons of natural history tastes in South Africa (and, indeed, in any other part of the world where our countrymen may be), and to give them fuller particulars about any special branch of natural history to which they may be attracted.

THE *Englishman*, of Calcutta, as quoted in the *British Medical Journal*, gives a summary of a resolution, extending over some 25 pages, which has been published in the Home Department on the chapters of the India Plague Commission dealing with the measures for the suppression of plague. Every aspect of the question is fully dealt with, and the main conclusions appear to be as follows: The government of India thinks the obligations of private persons and medical practitioners to report cases of sickness can be relied on only in very exceptional circumstances, and that the house-to-house visitations are justifiable only when plague exists in small well-defined areas. The government agrees with a surveillance over persons arriving from infected areas, and believes this means has been freely resorted to in rural areas, but does not favor the system of rewarding informers of plague cases. It publicly thanks the many volunteers who devoted themselves to the work of fighting the plague, and thinks the expense of special reporting agencies are fully compensated for by their success. Much attention is devoted to the question of corpse inspection, but on a review of the whole case the government considers the compulsory examination of bodies a very unpopular measure and its object is likely to be defeated. With regard to the compulsory removal to hospitals the Governor-General accepts the conclusion of the Commission, but desires that the removal should be compulsory only in places and under circumstances when it can be an effectual precaution. The removal of moribund patients is prohibited. Government agrees that the segregation of contacts should be abandoned as ineffective and harassing, except where special conditions are stated by the Commission to enable it to be carried out. The complete evacuation of villages and small towns when attacked is believed to be the most effective safeguard against the spread of the disease yet discovered. The question of disinfection is dealt with at length, and Government considers the Commission's advice generally excellent. Government and the Commission are in accord with the precautions taken regarding the annual pilgrimage to the Hedjaz, but the examination of the passengers from one infected port to another is now ordered to cease. With regard to the examination of railway passengers, all local governments are desired to report on the question of reducing the inspection stations, as from an economical point of view it is highly desirable now to maintain only those which are absolutely necessary; and, acting on the advice of the Commission, all disinfection stations maintained on the railways are ordered to be closed.

Consul-General Guenther writes to the Department of State from Frankfort, July 24, 1900: According to the *Electro-Technical Gazette*, German electrical works show great increase. On March 1st last, there were in operation 652 electrical works, against 489 the previous year. One hundred and twenty-two works were in progress of construction, of which 17 were to be ready for operation on July 1st. Twenty-seven were completed before 1890; all the others were constructed within the last ten years. The number of places with electric light exceeds that of places illuminated by gas—900 against 850. The largest electrical plant is at Rheinfelden, with 12,360 kilowatts. Then follow one at Berlin, 9230 kilowatts; one at Hamburg, 7290 kilowatts; one at Munich, 6110 kilowatts; two others at Berlin of 5452 and 5312 kilowatts, respectively; one at Strassburg, 4955 kilowatts; two others at Berlin, of 4676 and 4655 kilowatts, respectively; one at Chorzon, 4310 kilowatts; one at Frankfort, 4152 kilowatts; one at Dresden, 3580 kilowatts; one at Stuttgart, 3208 kilowatts; and another at Hamburg, 3150 kilowatts. All the electrical works supplied last year 2,623,803 incandescent lamps, 50,700 arc lamps, 106,368 horsepower for electromotors, etc.

UNIVERSITY AND EDUCATIONAL NEWS.

In the will of James F. Malcolm, a bequest of $10,000 to Rutgers College, is revoked by a codicil in which he says that his daughter will carry out his intentions as expressed by him to her prior to his death.

The will of the late Collis P. Huntington gives $100,000 to Hampden Institute, Virginia. His house on Fifth Avenue, of great value, is left to Yale University, in case his son has no children.

The trustees of the Lowell Textile School have received a gift from Mr. Frederick F. Ayer of $35,000 for the purchase of a site for the school which has been in operation three years on leased property. The State, by the last Legislature, provided $35,000 for the erection of the buildings, on condition that land and machinery to like amount should be provided, so the whole sum of $70,000 is now available for the establishment of the school in a permanent home. There are now five important textile schools in the United States: Philadelphia, Lowell and New Bedford, Mass., Clemson, S. C., and Atlanta, Ga.

The Fayerweather will case has been once more reopened. It is said that the expenses of the suits have been about $500,000.

Professor Karl Auwers, of Heidelberg, has been appointed director of the Chemical Institute of Griefswald, as successor to Professor Limprecht, who has retired.

SCIENCE

Friday, September 7, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

JAMES EDWARD KEELER.

The sudden death of Professor James E. Keeler, Director of the Lick Observatory, which occurred at San Francisco on August 12th, removes one who stood at the very forefront of astrophysical research. The advanced position occupied by the United States in the development of astrophysics is due as much to Keeler as to any other individual. The high quality of his own investigations, and the effect of his example on the work of others, have been factors of the first importance in building up the physical side of astronomy in this country. The shock caused by his wholly unexpected death has been felt by many, not least by some of those whose friendship for him grew out of a common interest in his own field of science.

As he was still in his forty-third year, and had until recently enjoyed the best of health, there seemed to be every reason to expect that his important contributions to astrophysical literature would continue for many years to come. But a severe cold, contracted in the course of his recent work with the Crossley reflector, developed into pneumonia, which was complicated with heart trouble. From the accounts which have so far reached us it appears that he withstood this first illness, and had just entered a hospital in San Francisco, when he was seized with an apoplectic stroke from which he did not rally.

James Edward Keeler was born at La Salle, Illinois, on September 8, 1857. As a boy he was greatly interested in science, and I have often heard him speak of his early chemical experiments and astronomical observations made with instruments of his own construction. His father, who was a paymaster in the navy, served with distinction in the civil war, and was on board the *Monitor* during her memorable fight with the *Merrimac.* Keeler's qualifications for scientific work clearly showed themselves at the Johns Hopkins University, where he took an undergraduate course, and served as assistant to Professor Hastings, with whom he observed the total solar eclipse of 1878 in Colorado. His report on the eclipse, which is accompanied by a drawing of the corona, is a characteristically clear and concise paper.

Shortly after this he was appointed assistant at the Allegheny Observatory, where he had an important part in the long series of bolometric investigations carried on by Professor Langley, then Director of the Observatory. In July, 1881, he was a member of Professor Langley's well-known expedition to Mount Whitney, in Southern California, where an extensive region in the extreme infra-red of the solar spectrum was discovered with the bolometer.* Later he studied for two years in Berlin and Heidelberg under Helmholtz and Quincke, and returned to the Allegheny Observatory, where he remained until appointed a member of the staff of the Lick Observatory. His work on Mt. Hamilton commenced in 1886, and for some time he was the only astronomer at the Observatory, which was still in process of construction. In May, 1891, he was elected Professor of Astrophysics in the Western University of Pennsylvania and Director of the Allegheny Observatory. In June of the same year he married Miss Matthews, a niece of Captain Floyd, President of the Lick Trust, with whose family she had lived on Mt. Hamilton.

Keeler's work at the Lick Observatory, of which more will be said in what follows, was continued in a most effective manner with the modest instrumental resources at Allegheny. His work here might well serve as an object lesson to those who complain of their inability to obtain useful results because they do not happen to have instruments of the largest size at their disposal. With a full understanding of the art of making the most of his means, he took up photography for the first time, made himself thoroughly familiar with photographic processes, and then, with the aid of a spectrograph whose general design has been followed in the construction of the great modern spectrographs at Mt. Hamilton, Potsdam, Pulkowa and Williams Bay, he obtained the photographs of the spectra of red stars which excited so much interest at the dedication of the Yerkes Observatory. He also made an admirable series of drawings of Mars, which was published in the *Memoirs* of the Royal Astronomical Society. In 1893 he accompanied the writer on an astrophysical expedition to Pike's Peak, where his experience and assistance were invaluable. In the same year, in company with Professors Crew and Ames, he joined me in editing the astrophysical part of *Astronomy and Astrophysics.* The *Astrophysical Journal* was established in 1895, and Keeler became joint editor with myself of the new publication. Until his return to Mt. Hamilton in 1898, where distance prevented him from taking an active part in the editorial work, he gave much time to the Journal, which owes much to his labors.

Keeler's spectroscopic proof of the meteoric constitution of Saturn's rings was made at Allegheny in the spring of 1895. In October, 1895, at the writer's request, he made at Cambridgeport the tests of the 40-inch object-glass of the Yerkes telescope which led to its final acceptance. Two years later, at the dedication of the Yerkes Observatory, he delivered an excellent address 'On the Importance of Astrophysical

*A peak in the Mt. Whitney range was named 'Keeler's Needle.'

Research and the Relation of Astrophysics to other Physical Sciences.' In the spring of 1898 he had practically decided to accept a position on the staff of the Yerkes Observatory, and would have done so had he not just then been appointed Director of the Lick Observatory. Strenuous efforts were made by the citizens of Allegheny to retain him, and a project for a new Allegheny Observatory was set on foot by Dr. J. A. Brashear, who has since carried it to a successful conclusion, though at the time in question it was impossible to raise the necessary funds. At the Yerkes Observatory our regret in losing so able and genial a coadjutor was tempered by the feeling that the cause of science would undoubtedly be best advanced by placing such a man in charge of the great institution on Mt. Hamilton.

This view has been most amply justified by the recent work of the Lick Observatory, which has attained the highest degree of efficiency under Keeler's administration. The activity of the Observatory in various fields of research, and the uniform excellence of observations made by men working under the inspiration of able leadership, have been recognized by all who keep in touch with astronomical progress.

But Keeler's recent work on Mt. Hamilton has not been confined to the direction of the affairs of a great observatory. The remarkable success of his experiments with the Crossley reflector, of which a full account is fortunately preserved in the June number of the *Astrophysical Journal*, has impressed everyone who has seen the wonderful photographs of nebulæ and star clusters made with this instrument. The record of this work, like that of many other events in Keeler's career, is full of instruction to those who aspire to achieve success as investigators. When entering upon his duties at Mt. Hamilton, Keeler called together the members of the staff to confer upon the observations to be undertaken. It is customary to divide the nights of the week with the great telescope among several observers, each of whom is pursuing a certain class of observations. When the division had been completed it was remarked with surprise—for the privilege of using such a telescope is highly valued—that Keeler had taken no nights for himself. On the contrary, instead of benefiting by the advantages which must have resulted from the use of the powerful and perfect refractor, he had chosen the difficult and rather uninviting task of bringing into use the Crossley reflector, an instrument of great optical power, but provided with a mounting of such design and construction as to render it almost unfit for exacting work. Although transferred from England to Mt. Hamilton several years before, no results had been obtained with this telescope in its new location. The reflector was best adapted optically for the photography of faint nebulæ, but mechanically it was not adequate for such work which more than any other demands a mounting of the highest stability and perfection of detail. The story of how obstacle after obstacle was encountered and overcome is modestly told in the paper to which reference has been made. The resulting photographs of nebulæ far surpass any similar photographs ever before obtained, and reveal new and unexpected features of the first importance. Hundreds of hitherto unknown nebulæ were discovered on the plates, and from an examination of these a fact of great significance was established, viz: that the majority of the nebulæ are spiral in form. It has long been known that certain of these cloud-like masses, from which the stars are supposed to be formed, show a spiral structure, but these were considered to be exceptions, and by no means type objects. As the result of Keeler's work it does not appear improbable that future theories of stellar evolution will start from the spiral rather than from the sphere of La Place's nebular hypothesis.

Of Keeler's other contributions to science two in particular deserve present mention: his determination with the Lick telescope of the motion in the line of sight of the planetary nebulæ and his demonstration of the meteoric constitution of Saturn's rings. The memoir which describes the first of these investigations already ranks as a classic of astrophysical literature. From the well-known principle of Doppler, the lines in the spectrum of a moving luminous object are displaced toward the violet or red according as the motion is directed toward or away from the observer. The spectrum of the planetary nebulæ consists of a small number of bright lines, which under high dispersion are widely separated from one another, but not greatly weakened in intensity. Keeler was the first to take advantage of this fact by using in the powerful spectroscope, designed by himself for the Lick telescope, a closely ruled Rowland grating. With the great dispersion of the fourth order spectrum, he was able to measure the positions of the nebular lines with an accuracy far surpassing that attained in any previous observations of these faintly luminous objects. The resulting velocities of the nebulæ in the line of sight were on the average considerably smaller than the extreme values, of which the greatest motion of approach was that of the nebula *G. C.* 4373, 40.2 miles per second, while the greatest motion of recession was 30.1 miles per second, for the nebula *N. G. C.* 6790. It was also found that the distance between the Great Nebula of Orion and the Sun is increasing at the rate of about 11.0 miles per second. On account of the thorough manner in which this research was planned, the skill exhibited in designing the spectroscope for the Lick telescope, the care taken in executing the measures and eliminating possible sources of error, and the completeness of the discussion of the observational material, Keeler's memoir on this subject in Volume III of the *Publications of the Lick Observatory* takes rank with the best examples of astrophysical literature.

The spectroscopic demonstration of the meteoric constitution of Saturn's rings is perhaps the most striking of the many effective applications which have been made of Doppler's fruitful principle. It has already been pointed out that the displacement of a line is proportional to the velocity of the luminous source. If an image of Saturn is formed on the slit of a spectroscope placed parallel to the planet's equator it is evident that all the lines in the photograph of the spectrum will be slightly twisted out of the vertical position they would occupy if the planet were not rotating on its axis. The displacement due to the rotation increases uniformly from the center of the disk to the circumference, and the lines, though inclined, remain perfectly straight. If the rings were solid, forming a continuous mass with the ball of the planet, it is evident that the spectral lines would be direct extensions of those due to the disk. But Keeler found from a study of his photographs that in passing from the spectrum of the disk to that of the rings the lines were not only displaced as a whole, but twisted in the opposite direction. In other words, it appeared that the velocity of rotation of the inner edge of the ring is greater than that of the outer edge, a result evidently incompatible with the existence of a solid ring, but perfectly in harmony with what must be true if the rings consist of swarms of discrete particles. Careful measurements of the photographs furnished the first direct confirmation of the early theoretical researches of Maxwell, who had shown mathematically that the rings could not exist as solid bodies.

Much more might be said of Keeler's work, but this should suffice to indicate its lasting value. It is a satisfaction to add that its merit has been widely appreciated, as has recently been evidenced by the award of the Draper and Rumford medals. Keeler was president of the Astronomical Society of the Pacific and a councilor of the Astronomical and Astrophysical Society of America. He was elected an Associate of the Royal Astronomical Society in 1898 and a member of the National Academy of Sciences at its last meeting. His kindly and genial manner, combined with unusual tact and rare judgment, drew to him many friends, who will long mourn his loss.

GEORGE E. HALE.

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*ADDRESS OF THE PRESIDENT BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.**

I.

TWENTY-SEVEN years ago the British Association met in Bradford, not at that time raised to the dignity of a city. The meeting was very successful, and was attended by about 2000 persons—a forecast, let us hope, of what we may expect at the present assembly. A distinguished chemist, Professor A. W. Williamson, presided. On this occasion the Association has selected for the presidential chair one whose attention has been given to the study of an important department of biological science. His claim to occupy, however unworthily, the distinguished position in which he has been placed, rests, doubtless, on the fact that, in the midst of the engrossing duties devolving on a teacher in a great university and school of medicine, he has endeavored to contribute to the sum of knowledge of the science which he professes. It is a matter of satisfaction to feel that the success of a meeting of this kind does not rest upon the shoulders of the occupant of the presidential chair, but is due to the eminence and active co-operation of the men of science who either preside over or engage in the work of the nine or ten sections into which the Association is divided, and to the energy and ability for organization displayed by the local secretaries and committees. The program prepared by the general and local officers of the Association shows that no efforts have been spared to provide an ample bill of fare, both in its scientific and social aspects. Members and Associates will, I feel sure, take away from the Bradford meeting as pleasant memories as did our colleagues of the corresponding Association Française, when, in friendly collaboration at Dover last year, they testified to the common citizenship of the Universal Republic of Science. As befits a leading center of industry in the great county of York, the applications of science to the industrial arts and to agriculture will form subjects of discussion in the papers to be read at the meeting.

* Given at Bradford on September 5, 1900.

Since the Association was at Dover a year ago, two of its former presidents have joined the majority. The Duke of Argyll presided at the meeting in Glasgow so far back as 1855. Throughout his long and energetic life he proved himself to be an eloquent and earnest speaker, one who gave to the consideration of public affairs a mind of singular independence, and a thinker and writer in a wide range of human knowledge. Sir J. William Dawson was president at the meeting in Birmingham in 1886. Born in Nova Scotia in 1820, he devoted himself to the study of the geology of Canada, and became the leading authority on the subject. He took also an active and influential part in promoting the spread of scientific education in the Dominion, and for a number of years he was principal and vice-chancellor of the McGill University, Montreal.

SCIENTIFIC METHOD.

Edward Gibbon has told us that diligence and accuracy are the only merits which an historical writer can ascribe to himself. Without doubt they are fundamental qualities necessary for historical research, but in order to bear fruit they require to be exercised by one whose mental qualities are such as to enable him to analyze the data brought together by his diligence, to discriminate between the false and the true, to possess an insight into the complex motives that determine human action, to be able to recognize those facts and incidents which had exercised either a primary or only a secondary influence on the affairs of nations, or on the thoughts and doings of the person whose character he is depicting.

In scientific research, also, diligence and accuracy are fundamental qualities. By their application new facts are discovered and tabulated, their order of succession is ascertained, and a wider and more intimate knowledge of the processes of nature is acquired. But to decide on their true significance a well-balanced mind and the exercise of prolonged thought and reflection are needed. William Harvey, the father of exact research in physiology, in his memorable work 'De Motu Cordis et Sanguinis,' published more than two centuries ago, tell us of the great and daily diligence which he exercised in the course of his investigations, and the numerous observations and experiments which he collated. At the same time he refers repeatedly to his cogitations and reflections on the meaning of what he had observed, without which the complicated movements of the heart could not have been analyzed, their significance determined, and the circulation of the blood in a continuous stream definitely established. Early in the present century, Carl Ernst von Baer, the father of embryological research, showed the importance which he attached to the combination of observation with meditation by placing side by side on the title page of his famous treatise 'Ueber Entwickelungsgeschichte der Thiere' (1828) the words *Beobachtung und Reflexion.*

Though I have drawn from biological science my illustrations of the need of this combination, it must not be inferred that it applies exclusively to one branch of scientific inquiry; the conjunction influences and determines progress in all the sciences, and when associated with a sufficient touch of imagination, when the power of seeing is conjoined with the faculty of foreseeing, of projecting the mind into the future, we may expect something more than the discovery of isolated facts; their co-ordination and the enunciation of new principles and laws will necessarily follow.

Scientific method consists, therefore, in close observation, frequently repeated so as to eliminate the possibility of erroneous seeing; in experiments checked and controlled in every direction in which fallacies might arise; in continuous reflection on the appearances and phenomena observed, and in logically reasoning out their meaning and the conclusions to be drawn from them. Were the method followed out in its integrity by all who are engaged in scientific investigations, the time and labor expended in correcting errors committed by ourselves or by other observers and experimentalists would be saved, and the volumes devoted annually to scientific literature would be materially diminished in size. Were it applied, as far as the conditions of life admit, to the conduct and management of human affairs, we should not require to be told, when critical periods in our welfare as a nation arise, that we shall muddle through somehow. Recent experience has taught us that wise discretion and careful prevision are as necessary in the direction of public affairs as in the pursuit of science, and in both instances, when properly exercised, they enable us to reach with comparative certainty the goal which we strive to attain.

IMPROVEMENTS IN MEANS OF OBSERVATION.

Whilst certain principles of research are common to all the sciences, each great division requires for its investigation specialized arrangements to insure its progress. Nothing contributes so much to the advancement of knowledge as improvements in the means of observation, either by the discovery of new adjuncts to research, or by a fresh adaptation of old methods. In the industrial arts, the introduction of a new kind of raw material, the recognition that a mixture or blending is often more serviceable than when the substances employed are uncombined, the discovery of new processes of treating the articles used in manufactures, the invention of improved machinery, all lead to the expansion of trade, to the occupation of the people, and to the development of great industrial centers. In science, also, the invention and employment of new and more precise instruments and appliances enable us to appreciate more clearly the signification of facts and phenomena which were previously obscure, and to penetrate more deeply into the mysteries of nature. They mark fresh departures in the history of science, and provide a firm base of support from which a continuous advance may be made and fresh conceptions of nature can be evolved.

It is not my intention, even had I possessed the requisite knowledge, to undertake so arduous a task as to review the progress which has recently been made in the great body of sciences which lie within the domain of the British Association. As my occupation in life has required me to give attention to the science which deals with the structure and organization of the bodies of man and animals—a science which either includes within its scope or has intimate and widespread relations to comparative anatomy, embryology, morphology, zoology, physiology, and anthropology—I shall limit myself to the attempt to bring before you some of the more important observations and conclusions which have a bearing on the present position of the subject. As this is the closing year of the century it will not, I think, be out of place to refer to the changes which a hundred years have brought about in our fundamental conceptions of the structure of animals. In science, as in business, it is well from time to time to take stock of what we have been doing, so that we may realize where we stand and ascertain the balance to our credit in the scientific ledger.

So far back as the time of the ancient Greeks it was known that the human body and those of the more highly organized animals were not homogeneous, but were built up of parts, the *partes dissimilares* (τὰ ἀνόμοια μέρη) of Aristotle, which differed from each other in form, color, texture, consistency and properties. These parts were familiarly known as the bones, muscles, sinews, blood-vessels, glands, brain, nerves, and so on. As the centuries rolled on, and as observers and observations multiplied, a more and more precise knowledge of these parts throughout the animal kingdom was obtained, and various attempts were made to classify animals in accordance with their forms and structure. During the concluding years of the last century and the earlier part of the present, the Hunters, William and John, in our country, the Meckels in Germany, Cuvier and St. Hilaire in France, gave an enormous impetus to anatomical studies, and contributed largely to our knowledge of the construction of the bodies of animals. But whilst by these and other observers the most salient and, if I may use the expression, the grosser characters of animal organization had been recognized, little was known of the more intimate structure or texture of the parts. So far as could be determined by the unassisted vision, and so much as could be recognized by the use of a simple lens, had indeed been ascertained, and it was known that muscles, nerves and tendons were composed of threads or fibers, that the blood- and lymph-vessels were tubes, and that the parts which we call fasciæ and aponeuroses were thin membranes, and so on.

Early in the present century Xavier Bichat, one of the most brilliant men of science during the Napoleonic era in France, published his 'Anatomie Générale,' in which he formulated important general principles. Every animal is an assemblage of different organs, each of which discharges a function, and acting together, each in its own way, assists in the preservation of the whole. The organs are, as it were, special machines situated in the general building which constitutes the factory or body of the individual. But, further, each organ or special machine is itself formed of tissues which possess different properties. Some, as the blood-vessels, nerves, fibrous tissues, etc., are generally distributed throughout the animal body, whilst others, as bones, muscles, cartilage, etc., are found only in certain definite localities. Whilst Bichat had acquired a definite philosophical conception of the general principles of construction and of the distribution of the tissues, neither he nor his pupil Béclard was in a position to determine the essential nature of the structural elements. The means and appliances at their disposal and at that of other observers in their generation were not sufficiently potent to complete the analysis.

Attempts were made in the third decennium of this century to improve the methods of examining minute objects by the manufacture of compound lenses, and, by doing away with chromatic and spherical aberration, to obtain, in addition to magnification of the object, a relatively large flat field of vision with clearness and sharpness of definition. When in January, 1830, Joseph Jackson Lister read to the Royal Society his memoir 'On some properties in achromatic object-glasses applicable to the improvement of microscopes,' he announced the principles on which combinations of lenses could be arranged, which would possess these qualities. By the skill of our opticians, microscopes have now for more than half a century been constructed which, in the hands of competent observers, have influenced and extended biological science with results comparable with those obtained by the astronomer through improvements in the telescope.

In the study of the minute structure of plants and animals the observer has frequently to deal with tissues and organs, most of which possess such softness and delicacy of substance and outline that, even when microscopes of the best construction are employed, the determination of the intimate nature of the tissue, and the precise relation which one element of an organ bears to the other constituent elements, is in many instances a matter of difficulty. Hence additional methods have had to be devised in order to facilitate study and to give precision and accuracy to our observations. It is difficult for one of the younger generation of biologists, with all the appliances of a well-equipped laboratory at his command, with experienced teachers to direct him in his work, and with excellent text-books, in which the modern methods are described, to realize the conditions under which his predecessors worked half a century ago. Laboratories for minute biological research had not been constructed, the practical teaching of histology and embryology had not been organized, experience in methods of work had not accumulated; each man was left to his individual efforts, and had to puzzle his way through the complications of structure to the best of his power. Staining and hardening reagents were unknown. The doublebladed knife invented by Valentin, held in the hand, was the only improvement on the scapel or razor for cutting thin, more or less translucent slices suitable for microscopic examination; mechanical section cutters and freezing arrangements had not been devised. The tools at the disposal of the microscopist were little more than knife, forceps, scissors, needles; with acetic acid, glycerine and Canada balsam as reagents. But in the employment of the newer methods of research care has to be taken, more especially when hardening and staining reagents are used, to discriminate between appearances which are to be interpreted as indicating natural characters, and those which are only artificial productions.

Notwithstanding the difficulties attendant on the study of the more delicate tissues, the compound achromatic microscope provided anatomists with an instrument of great penetrative power. Between the years 1830 and 1850 a number of acute observers applied themselves with much energy and enthusiasm to the examination of the minute structure of the tissues and organs in plants and animals.

CELL THEORY.

It had, indeed, long been recognized that the tissues of plants were to a large extent composed of minute vesicular bodies, technically called cells (Hooke, Malpighi, Grew). In 1831 the discovery was made by the great botanist, Robert Brown, that in many families of plants a circular spot, which he named areola or nucleus, was present in each cell; and in 1838 M. J. Schleiden published the fact that a similar spot or nucleus was a universal elementary organ in vegetables. In the tissues of animals also structures had begun to be recognized comparable with the cells and nuclei of the vegetable tissues, and in 1839 Theodore Schwann announced the important generalization that there is one universal principle of development for the elementary part of organisms, however different they may be in appearance, and that this principle is the formation of cells. The enunciation of the fundamental principle that the elementary tissues consisted of cells constituted a step in the progress of biological science, which will forever stamp the century now drawing to a close with a character and renown equalling those which it has derived from the most brilliant discoveries in the physical sciences. It provided biologists with the visible anatomical units through which the external forces operating on, and the energy generated in, living matter come into play. It dispelled forever the old mystical idea of the influence exercised by vapors or spirits in living organisms. It supplied the physiologist and pathologist with the specific structures through the agency of which the functions of organisms are discharged in health and disease. It exerted an enormous influence on the progress of practical medicine. A review of the progress of knowledge of the cell may appropriately enter into an address on this occasion.

STRUCTURE OF CELLS.

A cell is a living particle, so minute that it needs a microscope for its examination; it grows in size, maintains itself in a state of activity, responds to the action of stimuli, reproduces its kind, and in the course of time it degenerates and dies.

Let us glance at the structure of a cell to determine its constituent parts and the *rôle* which each plays in the function to be discharged. The original conception of a cell, based upon the study of the vegetable tissues, was a minute vesicle enclosed by a definite wall, which exercised chemical or metabolic changes on the surrounding material and secreted into the vesicle its characteristic contents. A similar conception was at first also entertained regarding the cells of animal tissues; but as observations multiplied, it was seen that numerous elementary particles, which were obviously in their nature cells, did not possess an enclosing envelope. A wall ceased to have a primary value as a constituent part of a cell, the necessary vesicular character of which therefore could no longer be entertained.

The other constituent parts of a cell are the cell plasm, which forms the body of the cell, and the nucleus imbedded in its substance. Notwithstanding the very minute size of the nucleus, which even in the largest cells is not more than $\frac{1}{500}$th inch in diameter, and usually is considerably smaller, its almost constant form, its well-defined sharp outline, and its power of resisting the action of strong reagents when applied to the cell, have from the period of its discovery by Robert Brown caused histologists to bestow on it much attention. Its structure and chemical composition; its mode of origin; the part which it plays in the formation of new cells, and its function in nutrition and secretion have been investigated.

When examined under favorable conditions in its passive or resting state, the nucleus is seen to be bounded by a membrane which separates it from the cell plasm and gives it the characteristic sharp contour. It contains an apparently structureless nuclear substance, nucleoplasm or enchylema, in which are embedded one or more extremely minute particles called nucleoli, along with a network of exceedingly fine threads or fibers, which in the active living cell play an essential part in the production of new nuclei within the cell. In its chemical composition the nuclear substance consists of albuminous plastin and globulin; and of a special material named nuclein, rich in phosphorus and with an acid reaction. The delicate network within the nucleus consists apparently of the nuclein, a substance which stains with carmine and other dyes, a property which enables the changes, which take place in the network in the production of young cells, to be more readily seen and followed out by the observer.

The mode of origin of the nucleus and the part which it plays in the production of new cells have been the subject of much discussion. Schleiden, whose observations, published in 1838, were made on the cells of plants, believed that within the cell a nucleolus first appeared, and that around it molecules aggregated to form the nucleus. Schwann again, whose observations were mostly made on the cells of animals, considered that an amorphous material existed in organized bodies, which he called cytoblastema. It formed the contents of cells, or it might be situated free or external to them. He figuratively compared it to a mother liquor in which crystals are formed. Either in the cytoblastema within the cells or in that situated external to them, the aggregation of molecules around a nucleolus to form a nucleus might occur, and, when once the nucleus had been formed, in its turn it would serve as a center of aggregation of additional molecules from which a new cell would be produced. He regarded therefore the formation of nuclei and cells as possible in two ways: one within pre-existing cells (endogenous cell-formation), the other in a free blastema lying external to cells (free cell-formation). In animals, he says, the endogenous method is rare, and the customary origin is in an external blastema. Both Schleiden and Schwann considered that after the cell was formed the nucleus had no permanent influence on the life of the cell, and usually disappeared.

Under the teaching principally of Henle, the famous Professor of Anatomy in Göttingen, the conception of the free formation of nuclei and cells in a more or less fluid blastema, by an aggregation of elementary granules and molecules, obtained so much credence, especially amongst those who were engaged in the study of pathological processes, that the origin of cells within pre-existing cells was to a large extent lost sight of. That a parent cell was requisite for the production of new cells seemed to many investigators to be no longer needed. Without doubt this conception of free cell-formation contributed in no small degree to the belief, entertained by various observers that the simplest plants and animals might arise, without pre-existing parents, in organic fluids destitute of life, by a process of spontaneous generation; a belief which prevailed in many minds almost to the present day. If, as has been stated, the doctrine of abiogenesis cannot be experimentally refuted, on the other hand it has not been experimentally proved. The burden of proof lies with those who hold the doctrine, and the evidence that we possess is all the other way.

MULTIPLICATION OF CELLS.

Although von Mohl, the botanist, seems to have been the first to recognize (1835) in plants a multiplication of cells by division, it was not until attention was given to the study of the egg in various animals, and to the changes which take place in it, attendant on fertilization, that in the course of time a much more correct conception of the origin of the nucleus and of the part which it plays in the formation of new cells was obtained. Before Schwann had published his classical memoir in 1839, von Baer and other observers had recognized within the animal ovum the germinal vesicle, which obviously bore to the ovum the relation of a nucleus to a cell. As the methods of observation improved, it was recognized that, within the developing egg, two vesicles appeared where one only had previously existed, to be followed by four vesicles, then eight, and so on in multiple progression until the ovum contained a multitude of vesicles, each of which possessed a nucleus. The vesicles were obviously cells which had arisen within the original germ-cell or ovum. These changes were systematically described by Martin Barry so long ago as 1839 and 1840 in two memoirs communicated to the Royal Society of London, and the appearance produced, on account of the irregularities of the surface occasioned by the production of new vesicles, was named by him the mulberry-like structure. He further pointed out that the vesicles arranged themselves as a layer within the envelope of the egg or zona pellucida, and that the whole embryo was composed of cells filled with the foundations of other cells. He recognized that the new cells were derived from the germinal vesicle or nucleus of the ovum, the contents of which entered into the formation of the first two cells, each of which had its nucleus, which in its turn resolved itself into other cells, and by a repetition of the process into a greater number. The endogenous origin of new cells within a pre-existing cell and the process which we now term the segmentation of the yolk were successfully demonstrated. In a third memoir, published in 1841, Barry definitely stated that young cells originated through division of the nucleus of the parent cell, instead of arising, as a product of crystallization, in the fluid cytoblastema of the parent cell or in a blastema situated external to the cell.

In a memoir published in 1842, John Goodsir advocated the view that the nucleus is the reproductive organ of the cell, and that from it, as from a germinal spot, new cells were formed. In a paper, published three years later, on nutritive centers, he described cells, the nuclei of which were the permanent source of successive broods of young cells, which from time to time occupied the cavity of the parent cell. He extended also his observations on the endogenous formation of cells to the cartilage cells in the process of inflammation and to other tissues undergoing pathological changes. Corroborative observations on endogenous formation were also given by his brother Harry Goodsir in 1845. These observations on the part which the nucleus plays by cleavage in the formation of young cells by endogenous development from a parent center—that an organic continuity existed between a mother cell and its descendants through the nucleus—constituted a great step in advance of the views entertained by Schleiden and Schwann, and showed that Barry and the Goodsirs had a deeper insight into the nature and functions of cells than was possessed by most of their contemporaries, and are of the highest importance when viewed in the light of recent observations.

In 1841 Robert Remak published an account of the presence of two nuclei in the blood corpuscles of the chick and the pig, which he regarded as evidence of the production of new corpuscles by division of the nucleus within a parent cell; but it was not until some years afterwards (1850 to 1855) that he recorded additional observations and recognized that division of the nucleus was the starting-point for the multiplication of cells in the ovum and in the tissues generally. Remak's view was that the process of cell division began with the cleavage of the nucleolus, followed by that of the nucleus, and that again by cleavage of the body of the cell and of its membrane. Kölliker had previously, in 1843, described the multiplication of nuclei in the ova of parasitic worms, and drew the inference that in the formation of young cells within the egg the nucleus underwent cleavage, and that each of its divisions entered into the formation of a new cell. By these observations, and by others subsequently made, it became obvious that the multiplication of animal cells, either by division of the nucleus within the cell, or by the budding off of a part of the protoplasm of the cell, was to be regarded as a widely spread and probably a universal process, and that each new cell arose from a parent cell.

Pathological observers were, however, for the most part inclined to consider free cell-formation in a blastema or exudation by an aggregation of molecules, in accordance with the views of Henle, as a common phenomenon. This proposition was attacked with great energy by Virchow in a series of memoirs published in his 'Archiv,' commencing in Vol. I., 1847, and finally received its death-blow in his published lectures on 'Cellular Pathology,' 1858. He maintained that in pathological structures there was no instance of cell development *de novo;* where a cell existed, there one must have been before. Cell-formation was a continuous development by descent, which he formulated in the expression *omnis cellula e cellulâ.*

KARYOKINESIS.

Whilst the descent of cells from pre-existing cells by division of the nucleus during the development of the egg, in the embryos of plants and animals, and in adult vegetable and animal tissues, both in healthy and diseased conditions, had now become generally recognized, the mechanism of the process by which the cleavage of the nucleus took place was for a long time unknown. The discovery had to be deferred until the optician had been able to construct lenses of a higher penetrative power, and the microscopist had learned the use of coloring agents capable of dyeing the finest elements of the tissues. There was reason to believe that in some cases a direct cleavage of the nucleus, to be followed by a corresponding division of the cell into two parts, did occur. In the period between 1870 and 1880 observations were made by Schneider, Strasburger, Bütschli, Fol, van Beneden and Flemming, which showed that the division of the nucleus and the cell was due to a series of very remarkable changes, now known as indirect nuclear and cell division, or karyokinesis. The changes within the nucleus are of so complex a character that it is impossible to follow them in detail without the use of appropriate illustrations. I shall have to content myself, therefore, with an elementary sketch of the process.

I have previously stated that the nucleus in its passive or resting stage contains a very delicate network of threads or fibers. The first stage in the process of nuclear division consists in the threads arranging themselves in loops and forming a compact coil within the nucleus. The coil then becomes looser, the loops of threads shorten and thicken, and somewhat later each looped thread splits longitudinally into two portions. As the threads stain when coloring agents are applied to them, they are called chromatin fibers, and the loose coil is the chromosome (Waldeyer).

As the process continues, the investing membrane of the nucleus disappears, and the loops of threads arrange themselves within the nucleus so that the closed ends of the loops are directed to a common center, from which the loops radiate outwards and produce a starlike figure (aster). At the same time clusters of extremely delicate lines appear both in the nucleoplasm and in the body of the cell, named the achromatic figure, which has a spindle-like form with two opposite poles, and stains much more feebly than the chromatic fibers. The loops of the chromatic star then arrange themselves in the equatorial plane of the spindle, and bending round turn their closed ends towards the periphery of the nucleus and the cell.

The next stage marks an important step in the process of division of the nucleus. The two longitudinal portions, into which each looped thread had previously split, now separate from each other, and whilst one part migrates to one pole of the spindle, the other moves to the opposite pole, and the free ends of each loop are directed towards its equator (metakinesis). By this division of the chromatin fibers, and their separation from each other to opposite poles of the spindle, two star-like chromatin figures are produced (dyaster).

Each group of fibers thickens, shortens, becomes surrounded by a membrane, and forms a new or daughter nucleus (dispirem). Two nuclei therefore have arisen within the cell by the division of that which had previously existed, and the expression formulated by Flemming—*omnis nucleus e nucleo*—is justified. Whilst this stage is in course of being completed, the body of the cell becomes constricted in the equatorial plane of the spindle, and, as the constriction deepens, it separates into two parts, each containing a daughter nucleus, so that two nucleated cells have arisen out of a pre-existing cell.

A repetition of the process in each of these cells leads to the formation of other cells, and, although modifications in details are found in different species of plants and animals, the multiplication of cells in the egg and in the tissues generally on similar lines is now a thoroughly established fact in biological science.

In the study of karyokinesis, importance has been attached to the number of chromosomes in the nucleus of the cell. Flemming had seen in the Salamander twenty-four chromosome fibers, which seems to be a constant number in the cells of epithelium and connective tissues. In other cells again, especially in the ova of certain animals, the number is smaller, and fourteen, twelve, four, and even two only have been described. The theory formulated by Boveri that the number of chromosomes is constant for each species, and that in the karyokinetic figures corresponding numbers are found in homologous cells, seems to be not improbable.

In the preceding description I have incidentally referred to the appearance in the proliferating cell of an archromatic spindle-like figure. Although this was recognized by Fol in 1873, it is only during the last ten or twelve years that attention has been paid to its more minute arrangements and possible signification in cell-division.

The pole at each end of the spindle lies in the cell plasm which surrounds the nucleus. In the center of each pole is a somewhat opaque spot (central body) surrounded by a clear space, which, along with the spot, constitutes the centrosome or the sphere of attraction. From each centrosome extremely delicate lines may be seen to radiate in two directions. One set extends towards the pole at the opposite end of the spindle, and, meeting or coming into close proximity with radiations from it, constitutes the body of the spindle, which, like a perforated mantle, forms an imperfect envelope around the nucleus during the process of division. The other set of radiations is called the polar, and extends in the region of tbe pole towards the periphery of the cell.

The question has been much discussed whether any constituent part of the achromatic figure, or the entire figure, exists in the cell as a permanent structure in its resting phase; or if it is only present during the process of karyokinesis. During the development of the egg the formation of young cells, by division of the segmentation nucleus, is so rapid and continuous that the achromatic figure, with the centrosome in the pole of the spindle, is a readily recognizable object in each cell. The polar and spindle-like radiations are in evidence during karyokinesis, and have apparently a temporary endurance and function. On the other hand, van Beneden and Boveri were of opinion that the central body of the centrosome did not disappear when the division of the nucleus came to an end, but that it remained as a constituent part of a cell lying in the cell plasm near to the nucleus. Flemming has seen the central body with its sphere in leucocytes, as well as in epithelial cells and those of other tissues. Subsequently Heidenhain and other histologists have recorded similar observations. It would seem, therefore, as if there were reason to regard the centrosome, like the nucleus, as a permanent constituent of a cell. This view, however, is not universally entertained. If not always capable of demonstration in the resting stage of a cell, it is doubtless to be regarded as potentially present, and ready to assume, along with the radiations, a characteristic appearance when the process of nuclear division is about to begin.

One can scarcely regard the presence of so remarkable an appearance as the achromatic figure without associating with it an important function in the economy of the cell. As from the centrosome at the pole of the spindle both sets of radiations diverge, it is not unlikely that it acts as a center or sphere of energy and attraction. By some observers the radiations are regarded as substantive fibrillar structures, elastic or even contractile in their properties. Others, again, look upon them as morphological expressions of chemical and dynamical energy in the protoplasm of the cell body. On either theory we may assume that they indicate an influence, emanating, it may be, from the centrosome, and capable of being exercised both on the cell plasm and on the nucleus contained in it. On the contractile theory, the radiations which form the body of the spindle, either by actual traction of the supposed fibrillæ or by their pressure on the nucleus which they surround, might impel during karyokinesis the dividing chromosome elements towards the poles of the spindle, to form there the daughter nuclei. On the dynamical theory, the chemical and physical energy in the centrosome might influence the cell plasm and the nucleus, and attract the chromosome elements of the nucleus to the poles of the spindle. The radiated appearance would therefore be consequent and attendant on the physico-chemical activity of the centrosome. One or other of these theories may also be applied to the interpretation of the significance of the polar radiations.

CELL PLASM.

In the cells of plants, in addition to the cell wall, the cell body and the cell juice require to be examined. The material of the cell body, or the cell contents, was named by von Mohl (1846) protoplasm, and consisted of a colorless tenacious substance which partly lined the cell wall (primordial utricle), and partly traversed the interior of the cell as delicate threads enclosing spaces (vacuoles) in which the cell juice was contained. In the protoplasm the nucleus was embedded. Nägeli, about the same time, had also recognized the difference between the protoplasm and the other contents of vegetable cells, and had noticed its nitrogenous composition.

Though the analogy with a closed bladder or vesicle could no longer be sustained in the animal tissues, the name 'cell' continued to be retained for descriptive purposes, and the body of the cell was spoken of as a more or less soft substance enclosing a nucleus (Leydig). In 1861 Max Schultze adopted for the substance forming the body of the animal cell the term 'protoplasm.' He defined a cell to be a particle of protoplasm in the substance of which a nucleus was situated. He regarded the protoplasm, as indeed had previously beeen pointed out by the botanist Unger, as essentially the same as the contractile sarcode which constitutes the body and pseudopodia of the Amœba and other Rhizopoda. As the term 'protoplasm,' as well as that of 'bioplasm,' employed by Lionel Beale in a somewhat similar though not precisely identical sense, involves certain theoretical views of the origin and function of the body of the cell, it would be better to apply to it the more purely descriptive term 'cytoplasm' or 'cell plasm.'

Schultze defined protoplasm as a homogeneous, glassy, tenacious material, of a jelly-like or somewhat firmer consistency, in which numerous minute granules were embedded. He regarded it as the part of the cell especially endowed with vital energy, whilst the exact function of the nucleus could not be defined. Based upon this conception of the jelly-like character of protoplasm, the idea for a time prevailed that a structureless, dimly granular jelly or slime destitute of organization, possessed great physiological activity, and was the medium through which the phenomena of life were displayed.

More accurate conceptions of the nature of the cell plasm soon began to be entertained. Brücke recognized that the body of the cell was not simple, but had a complex organization. Flemming observed that the cell plasm contained extremely delicate threads, which frequently formed a network, the interspaces of which were occupied by a more homogeneous substance. Where the threads crossed each other, granular particles (mikrosomen) were situated. Bütschli considered that he could recognize in the cell plasm a honeycomb-like appearance, as if it consisted of excessively minute chambers in which a homogeneous more or less fluid material was contained. The polar and spindle-like radiations visible during the process of karyokinesis, which have already been referred to, and the presence of the centrosome, possibly even during the resting stage of the cell, furnished additional illustrations of differentiation within the cell plasm. In many cells there appears also to be a difference in the character of the cell plasm which immediately surrounds the nucleus and that which lies at and near the periphery of the cell. The peripheral part (ektoplasma) is more compact and gives a definite outline to the cell, although not necessarily differentiating into a cell membrane. The inner part (endoplasma) is softer, and is distinguished by a more distinct granular appearance, and by containing the products specially formed in each particular kind of cell during the nutritive process.

By the researches of numerous investigators on the internal organization of cells in plants and animal, a large body of evidence has now been accumulated, which shows that both the nucleus and the cell plasm consist of something more than a homogeneous, more or less viscid, slimy material. Recognizable objects in the form of granules, threads, or fibers can be distinguished in each. The cell plasm and the nucleus respectively are therefore not of the same constitution throughout, but possess polymorphic characters, the study of which in health and the changes produced by disease will for many years to come form important matters for investigation.

William Turner.

(*To be concluded.*)

EXPERIMENTS OF J. J. THOMSON ON THE STRUCTURE OF THE ATOM.

Recent ideas as to the stability of the chemical molecule have been much modified by the evidence that it is readily dissociated when a substance is dissolved in water.

The researches now being carried on by J. J. Thomson and his assistants on the electrical conduction of gases seem to require an even more radical and sweeping change in our conception of the structure of the atom itself.

Ordinary gases are perfect non-conductors of electricity of low electromotive force. Electricity may, however, pass through them, more or less readily, under certain conditions, viz:

1. When the electromotive force is sufficient to produce a spark.

2. When the pressure of the gas is much reduced and a sufficient electromotive force is applied; as in a 'vacuum tube.'

3. When the gas is heated very hot, or has been recently in violent chemical activity, as in the region above a flame.

4. When the negative electrode is illuminated by ultra-violet light.

5. When the gas has been very recently exposed to Röntgen rays or to the similar rays proceeding from uranium, radium, etc.

Thomson's investigations on the conduction by sparks through gases at ordinary pressures, indicated that electrolysis took place somewhat as in solutions, and that the amount of decomposition was, in several cases, essentially the same as in the decomposition of solutions. In the case of hot gases and the gases in a vacuum tube, also there was evidence that the conduction was by means of 'ions' or portions of broken-down molecules which acted as carriers for the current.

When an electric current passes through a solution, it is a fundamental law that a univalent atom of any substance carries precisely the same charge as a univalent atom of any other substance, while a bivalent atom carries just twice this charge. The exact charge carried by one atom cannot be known until we know the exact weight of the atom; but the charge carried by 1 gramme of atoms (e/m) is about 10,000 units in the case of hydrogen. For any other univalent substance, the weight required to carry this charge is greater in proportion as its atoms are heavier than those of hydrogen.

Thomson has undertaken to find the charge carried by the gaseous ion as follows: When the discharge of an induction coil is sent through a vacuum tube, there is seen a luminous glow, stretching in a straight line from the electrode to the wall of the tube. This glow, called the 'cathode ray' would seem to be a stream of negatively charged particles, from the cathode, or negative terminal in the tube, projected in a straight line until some solid obstacle is encountered. This cathode ray, when it meets the tube, or any body in its path, may produce fluorescence; it always produces heating, it also excites the vibrations called by Röntgen the X-ray.

A magnet held near the cathode ray draws it to one side, as if it were a conductor carrying an electric current. Professor Thomson has made use of this property to determine the ratio e/m for the electrified particles. Of course the more strongly the flying particles are charged, the more they will be drawn aside from their rectilinear path, while the heavier the particles, the more nearly would their inertia keep them in a straight line. The ratio of the charge to the mass of a particle determines its velocity at right angles to the original direction.

Again, the flying stream may be drawn aside from its course by an electrified plate at the side of the stream, by which it will be attracted or repelled according as the plate has a positive or negative charge.

Both these methods for deflecting the ray were employed. The energy of the flying particles was also determined from the heat which they produced when directed upon a thermopile; and the ratio of the charge upon the particles to their mass was thus found to be about 10^7, or nearly 1000 times as large as for the hydrogen atom in the electrolysis of solutions.

Again, when ultra-violet light falls upon an amalgamated zinc plate, the gas near the plate becomes conducting. Here again if a magnetic field is produced near the plate, the path of the charged particles is changed. This path can no longer be seen, as in the cathode ray; it may, however, be inferred from the change of conduction, when the distance between the electrodes is varied. The ratio of the charge to the mass of the particles is, in this case, the same as in the cathode ray, as above determined.

If, as is believed, the electric current in these cases consists of a stream of charged particles, we are apparently shut up to the alternative that the charge of each ion is 1000 times as great as is found in solutions, or that the mass of the ions is $\frac{1}{1000}$ as great as that of the hydrogen atom. Probably the former supposition seems much less opposed to our preconceived ideas than the latter, but it is a question to be decided by experiment rather than by preconceived ideas.

To make a direct measurement of the mass of the single ions, or particles taking part in electric conduction, Thomson examined air which had been rendered conducting by exposure to Röntgen rays. The quantity of electricity carried by such air is measured without special difficulty. To count the number of ions taking part in the conduction is quite another matter. This counting has, however, been actually accomplished in the following manner: Damp air, which has been freed from dust by filtering, is exposed to the Röntgen rays and its conductivity determined; it is then suddenly expanded to $1\frac{1}{3}$ times its volume. The expansion and consequent cooling, causes a fine fog or mist to form. It has been found that when such a mist is formed, there is at the center of each drop, a minute particle of dust, or other substance, upon which condensation has taken place. In this case, all the dust had been filtered out, but the charged ions performed the same duty of allowing condensation to begin, and hence the number of water drops is the same as the number of ions present in the air. To count the number of drops, the weight of the cloud is determined by a sensitive balance. They are also allowed to settle in a bell jar, and the rate of settling is observed. The calculations of Stokes, based upon the viscosity of air, show at what rate drops of different size will fall, and from this, the size of the water drops is determined. The size of the drops and the weight of the cloud give the total number of drops in the cloud, and hence the number of ions present in the air.

The result of this experiment turns out to be that the number of ions, carrying a unit quantity of electricity is perhaps a little less, certainly not very different, from the number carrying a unit quantity in the case of solutions. The other alternative seems to be the true one, that the mass of each ion (or 'corpuscle' as Thomson calls them) has about $\frac{1}{1000}$ the mass of the hydrogen atom. More than this, it seems to be the same for all the gases tried, instead of differing with their atomic weight, indicating that all these gases give off corpuscles of the same mass.

These results, revolutionary as they are, fit in well with some other facts. Thus, the stream of electrified particles constituting the cathode ray, is found to penetrate a mass of air much farther than would be expected if the ray were composed of particles as large as atoms, but just about as far as if they were $\frac{1}{1000}$ as large as hydrogen atoms. They also penetrate all gases in the inverse ratio of their densities. However, if the reason for this is to be found in the fact that their molecules are all built up of corpuscles of the same kind, it must also be true that the structure of the molecules is extremely porous, allowing the corpuscles to pass through them with great freedom.

Further confirmation of this theory is found in a recent discovery by Zeeman in spectrum analysis. When a luminous gas is between the poles of an electromagnet, the lines of its spectrum are found to be affected in such wise as to indicate that the particles whose vibrations produce the light are electrified; and the ratio of the charge to the mass of the particles is found to be the same as for Thomson's 'corpuscles.' Mendeleef, who has grouped the chemical elements into a remarkable series of families, says "the periodic law together with the revelations of spectrum analysis, have contributed again to revive an old, but remarkably long-lived hope, that of discovering * * * the primary matter, which had its genesis in the minds of the Grecian philosophers, and has been transmitted, together with many other ideas of the classic period, to the heirs of their civilization." "From the failures of so many attempts at finding in experiment and speculation, a proof of the compound character of the elements, and of the existence of primordial matter, it is evident, in my opinion, that this theory must be classed among mere Utopias."

It would seem that a beginning has been made in attaining this Utopia. The theory is too new and too extreme to have received the scrutiny and the criticism which it deserves. It yet remains to be seen whether it is consistent with the low internal energy of gaseous molecules, or whether it will prove valuable in explaining the electrical, magnetic or chemical properties of bodies. Its author has already published a number of suggestive 'speculations' as to the part played by corpuscles in electrical and heat conduction, in the Thomson effect, in the magnetism of rotating matter (terrestrial magnetism?) and in a number of the other electrical properties of bodies, which at least indicate some of the possibilities of the new theory in the domain of molecular physics.

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INVESTIGATIONS AT COLD SPRING HARBOR.

THE investigations at this Laboratory during the present summer have covered a wide field as the following enumeration of subjects and abstracts shows. In Botany work is being done in the determination of the species of the rich cryptogamic flora of the vicinity, in the study of the tension zone where fresh water and marine species meet and in various other ecological matters. In Zoology, investigations are being carried out on the supermatogenesis of certain higher crustacea, on the development of Trematodes, of Squilla, of Phascolosoma, of Pectinatella and of Hemiptera. Studies on the development of color markings in insects have made good progress, the insect fauna is being systematically studied, and the food habits of fishes are being analyzed. Quantitative variation studies are being carried out on sea anemones, Daphnia, Amphipoda, lamellibranchs, Myriapoda, several groups of insects and mice. The following brief statements give further details concerning some of these studies.

Cryptogamic Studies at Cold Spring Harbor: By DR. D. S. JOHNSON.

The work accomplished in the study of the cryptogams, aside from class work, has been chiefly systematic, including a study of the distribution of the marine algæ in various parts of Cold Spring Harbor, Huntington Harbor, and Smithtown Bay. Few new forms have been added to the flora, but forms hitherto known only from free fragments have been found abundantly in their natural habitat. Many notes have also been made as to the different species preponderating in the same locality in different years. Fungi have been much restricted in distribution and numbers because of the dry season, but several interesting finds have been made. Of the Myxomycetes, Mr. D. N. Shoemaker has added twelve additional genera and thirty-eight additional species to those reported from other sources in Jelliffe's list of Long Island plants and only one species mentioned by Jelliffe has not been seen here. Several specimens of Dictyophora (Ravenellii?) apparently new to the Island have been found and a group of over twenty specimens of *Simblum rubescens*, of which four had double stipes and an elongated receptaculum.

Studies in Ecology: By DR. HENRY C. COWLES.

The work in this department has been chiefly along two lines. Considerable attention has been paid to variations in form, especially in leaves, with a view to the suggestion of a series of hypotheses, which may be made the basis of further observation and experiment on these matters. Perhaps the most fruitful field of study has been in relation to the development of the Long Island vegetation in connection with the physiography. The succession of plant societies along the xerophytic shores strikingly resembles that along the Great Lakes. The genetic relations of salt, brackish and fresh swamps have been looked into, and one student has taken up this problem as a special field for research. Another student is preparing to make a comparative chemical analysis of forms which grow in both maritime and inland conditions. Two other students are contemplating leaf variation studies. Our present plans also include a series of culture experiments on halophytes conducted in the interior under various soil conditions.

Trematode Studies: By Dr. H. S. PRATT.

The adult form of Apoblema (Distoma) appendiculatum has been found in considerable numbers in the menhaden, attached to the wall of the stomach. Immature forms of this worm have been plentiful at Cold Spring Harbor during the past five years, although they have not been observed at any other part of the Atlantic coast of this country. They occur in the body-cavity of copepods and also free-swimming in the plankton.

Three species of Trematodes have been observed on the gills of *Fundulus heteroclitus.* Two of them are minute monogenetic Trematodes belonging to the genera *Tetraonchus* and *Gyrodactylus* which have not before been observed in North America. The species of *Tetraonchus* is undoubtedly a new one. It is found attached to the gills, from one to three individuals usually occurring on each fish. The species of *Gyrodactylus* was rare, but four individuals being found during five weeks on the large number of fishes examined. The species is probably new although it may prove to be identical with *G. Groenlandicus* Levinsen.

In addition to these monogenetic Trematodes large numbers of an encysted distomid worm belonging to the genus *Echinostomum* were also found. The cysts are oval in shape, each containing a single worm. These were found in all stages of development, the largest showing the two suckers, the digestive and excretory tracts, and the characteristic oral spines. In quite small fishes the cysts were either absent or contained very young worms, and numerous minute ciliated organisms, which were probably the miracidia of *Echinostomum* were found swimming rapidly over the surface of the gills or lying closely applied to them.

Development of Squilla Empusa: By Dr. C. P. Sigerfoos.

This interesting form has been found in great numbers and is apparently much more abundant than usual. It lives at low tide mark in muddy sand to soft mud, in burrows one to four feet or more in length and open at both ends. Observations on the development are in progress. The eggs, very numerous and less than a millimeter in diameter, are cemented into a large plate, which is rolled into a bunch and carried in a basket formed by the anterior thoracic appendages. The incubation seems to be slow, and the larvæ are about all hatched before August 1st. The new-hatched larva is two and a half millimeters long and of much more advanced organization than in the forms described by Claus. It moults in three days. The later stages have been taken in the tow-net and at this writing (August 11th), are seven millimeters long and in perhaps the sixth or seventh stage. The smallest adults found are over ten centimeters long indicating that this size is attained in one year.

Variations in Color pattern produced by Changes in Temperature and Moisture: By W. L. Tower.

The relations which exist between the variations of the color pattern, moisture and temperature conditions have been tested experimentally during the last two years in *Leptinotarsa decemlineata* Say, the Colorado potato beetle. Extremely abnormal conditions were avoided and only such deviations from the normal were used as might be encountered in different parts of North America. In several series of experiments known deviations of temperature and moisture were used and the results derived by quantitative methods.

The series of experiments show that a deviation above the normal (+) of either temperature or moisture, or both, up to a certain critical maximum, will produce melanism; but a deviation of either factor beyond this maximum will produce albinism. A deviation below the normal (—) produces albinism if both factors are —; but a + temperature and a — humidity produce albinic specimens; and a — temperature and a + humidity produce melanism up to the critical point where the opposite color variations begin to predominate.

A Study of the Variations in the Number of Grooves upon the Shells of Pecten irradians (Lam.): By FRANK E. LUTZ.

The material for this study was gathered from East Beach, Northport Bay, L. I., during the scallop season of 1899–1900. The Beach is an extremely well-protected one in an almost land-locked harbor. The results given by a count of five hundred specimens of each valve were as follows:

Lower valve.—Average = 17.456 ± 0.022; Standard Deviation = 0.726 ± 0.015; Coefficient of Variability = 4.163% ± 0.888%.

Upper valve.—Average = 17.110 ± 0.027; Standard Deviation = 0.922 ± 0.019; Coefficient of Variability = 5.388% ± 0.115%.

The curves obtained in both cases were nearly normal—that of the lower valve approaching the closer. The shells show the least variability of any Pectens yet studied.

Statistical Studies on Sand Fleas: By MABEL E. SMALLWOOD.

Five hundred sand fleas (Talorchestia), apparently adult, were gathered from the Sand Spit at Cold Spring Harbor. They ranged in length from 15 mm. to 27.5 mm. The length of the antennæ ranged from 5.5 mm. to 24.4 mm., the average was 13.01 mm. ± 0.14 mm. and the standard deviation was 4.67. Attempts to fit a theoretical unimodal curve were unsuccessful. From inspection of the distribution of frequencies it seems probable that the observed curve is multimodal with two principal modes placed so near together that their distinctness is hidden, and that these two modes correspond to two moultings. The length of the tentacle is proportionately much longer in the larger individuals and it seems probable that the two recognized species—*T. megalopthalma* and *T. longicornis* are merely two different moults of the same species. Breeding experiments are now in progress to test this conclusion.

Pedigree Mouse Breeding: By C. B. DAVENPORT.

Quantitative data are being collected from a colony of fifty mice of different races concerning inheritance of color and other measurable characteristics. Especially noteworthy are the relative prepotency of different races, reversion, the skipping of a generation in inheritance, the *localization* of white patches and of the other parental color-markings on particular parts of the body of the offspring. The results are not yet ready for publication.

C. B. DAVENPORT.

COLD SPRING HARBOR, L. I.,
August, 1900.

SCIENTIFIC BOOKS.

Tarr and McMurry's Geographies. First Book—Home Geography and the Earth as a Whole. Pp. xiii + 279. Second Book—North America, with an especial full treatment of the United States and its dependencies. By RALPH S. TARR and FRANK M. MCMURRY. New York, Macmillan. 1900. Pp. xviii + 469.

The first volume is a disappointment. The authors call it 'a radical innovation,' but the claim does not seem well founded. Apparently they have meant to make the Home Geography and the maps the *features*.

Home Geography is a misnomer for the book. The idea that the child ought to begin with the study of forms about him is good, but not new, and the idea is not realized in this volume. A few sentences connect hills and valleys and soils with environment; the mountains are said to look like clouds on the horizon. The rest is descriptive and not Home Geography at all.

Suggestions for further home study are appended to the chapters, 8 or 10 pages in the 280, but they are subordinate and will be neglected by most teachers as such, especially as teachers are still untrained in outdoor work.

For instance, the first suggestion is, "Find a place where men are digging a ditch or cellar, to see how the dirt looks below the surface"—an admirable thing to do, but the inertia of the ages is against its realization. The children will not do that part of the work unless it is talked of in class and the teacher cannot make anything of it unless she goes and does the work herself. She will not go without stronger urgings than these footnote-like suggestions. There is no evidence in this book that the authors have ever tried to teach children to look about them, and it does not appear that teachers trained in books only will be inspired by this one to begin outdoor studies for themselves.

Putting aside the pretence of basing the book on home study, the introduction on Physical Geography is good, though Frye is a predecessor in that line, and a worthy one.

The portion of the volume that treats of the United States is interesting and admirable, brightened continually by bits of realistic description from personal knowledge that are very effective. The pictures here, too, are admirable, for instance, the cowboy and horse at page 182.

The basing of descriptions on Physiography might be better. Thus in accounting for the greatness of New York City the hollow across the Appalachians in which the Mohawk flows is not mentioned and the real connection of New York with the interior not pointed out. For anything pointed out in the book the Mohawk might enter the Hudson by a narrow cañon. Yet canal and railroads are but utilizations of the open valley. Again, 'sinking of the land' cannot be bluntly stated to children as an intelligent reason for the embayed coast. The idea is one they have difficulty in grasping with much explanation, and to simplify by omitting explanation is unsatisfactory. So, too, cross-sections are used to explain mountain building without elucidation, as in Fig. 90, called a valley sliced through. Apart from the careless drawing of the diagram it is likely to remain a queer picture until the pupils' minds are prepared for it. The idea is yet geometric and even grown teachers have considerable trouble in understanding it on first acquaintance. Several pages are devoted to 'Reasons why Philadelphia is a great City,' and after reading them one is inclined to ask: 'Well, why?' The text does not make it clear why Trenton, for instance, did not take the greater growth.

The geography is constantly connected with history and this is done with much judgment. In describing Turkey a word might have been devoted to the presence of the Turks in Europe. Reference to p. 271 for height of the Spanish plateau (p. 230) fails to obtain information. Manitoba, described in the text is not on any of the maps. Under caravans (p. 234) a good opportunity was passed to show why camels travel in groups. The Manila house, p. 253, should be compared with the similar houses in the West Indies. If the Chinamen in this country are worth mentioning and their exclusion of foreigners from their territory, surely it was in order to note the present restrictions placed on their immigration here by our government. On p. 201 the impression is likely to be obtained that Spanish is spoken in Brazil and at 205 that Lima, eight miles from the Pacific, is an interior city.

The second part of the 'innovation' in this volume is in maps which by their small size allow the volumes to take the handy duodecimo size, 'unimportant names' being excluded. Comparison is challenged in the statement of belief that the 'maps are the best thus far printed in an American geography.'

Now the small size is no innovation of Tarr and McMurry. Professor Davis adopted it two years ago in his 'Physical Geography' and his long teaching of the adequacy of small maps for many purposes is not unknown to his pupils. Some of the maps here are very good indeed but they hardly surpass some of those in the American Book Company's new geographies, while some of the maps in the present volume are unpardonably bad, *e. g.*, the hemispheres, Fig. 119, Europe in Fig. 120, where simplicity of names is attained by representing Europe's chief cities as London, Paris, Berlin, St. Petersburg, Constantinople and Gibraltar (!). The two-page Europe, Fig. 183 has an orography worthy of the middle ages, the Alps being in northern Italy while Pyrenees, Apennines and Carpathians have altogether insignificant relief. The introduction of the map idea by the sketches in Fig. 91 is entirely amiss. The fundamental distinction between pictures and maps is the introduction of perspective in a picture. But the pretended views of Fig. 91 are not views at all but maps differently colored. The Nova Scotia St. Lawrence view for instance shows no foreshortening with distances, but the same defect is present in the first sketch. It is an attempt to teach by trickery; for being false maps they cannot convey the idea of what a map really is.

Now that the objections have been stated let me hasten to express a hope that the small size geography has come to stay.

The maps of North America, Fig. 123, and the New England States, Fig. 125, seem to me very beautiful maps, but will Brockton and Haverhill agree that Plymouth is more important in New England geography than they? The make-up of the book is attractive, but it should be much revised before being offered to the schools.

The good features of the volume are developed in the admirable *Second Book*, 'North America.' After occupying a quarter of their space with a hastily written account of general physical geography, the authors present a splendid picture of the varied life and industries of different parts of this country, profusely illustrated. This portion of the book is admirable. Where older or briefer books have contented themselves with stating occupations and products, Tarr and McMurray describe industries so vividly and realistically that the interest is absorbing. Professor Tarr's books make 'easy reading,' and this one is no exception. It is to be hoped the use of the volume will be widespread. The teacher's part will be easy. History and industry are both referred to a geographic basis.

Each volume is closed by statistical tables and a pronouncing vocabulary. The latter would be more valuable did it not attempt a closeness of sound reproduction that demands special knowledge of languages and sounds for proper handling. Some inconsistencies and mispronunciations result. Accent and sounds of Spanish words need special revision. *Tuscon* for Tucson is the only misprint noted in the two volumes though a number of errors in the pronunciation are very likely chargeable to the printer. The maps are admirable apart from the hemispheres and Mercator repeated from the First Book.

MARK S. W. JEFFERSON.

Wireless Telegraphy and Hertzian Waves. By S. R. BOTTONE. Whittaker & Co., London. Cloth. Pp. 116. 35 illustrations.

This little book contains a brief account of the phenomena of Hertzian waves and of the development of the system of transmitting signals known as wireless telegraphy. The first chapter is intended for readers who are not familiar with even the more elementary ideas concerning electrical phenomena. The second chapter gives a brief account of the historical development of wireless telegraphy, and the next chapter on Hertzian waves describes in a very simple manner the methods of generating these waves and some of the methods of detecting them, especially those employing the coherer. The chapter on constructional details, which comprises nearly half the book, contains directions for making in an inexpensive way the apparatus required for experiments in the field of wireless telegraphy.

The comparison which the author makes between the action of a coherer and the action of iron filings in a helix through which an electrical current is passing is rather a misleading one, and the impression is given that it is necessary to have the coherer circuit carefully tuned to the transmitting circuit in order to have the coherer respond. Otherwise for a simple presentation of so difficult a subject the book contains very few misleading statements.

F. L. T.

SCIENTIFIC JOURNALS AND ARTICLES.

IN the September number of *The American Journal of Physiology* J. Van Denburgh and O. B. Wright present a carefully prepared account of their experiments 'On the physiological action of the poisonous secretion of the Gila Monster (*Heloderma suspectum*).' They find that the poison is essentially like the various snake venoms in its effects. The rate of respiration, the activity of the heart, the irritability of the sensory apparatus, the rapidity of coagulation of the blood, all suffer first an increase, and later a retardation with a gradual total loss of function. This primary quickening and secondary paralysis is not seen in the vasomotor center; instead, the poison causes immediately a great fall in blood pressure due to vascular dilatation. The motor nerves are entirely unaffected. The red blood corpuscles are often rendered spherical by the poison, and, outside the body at least, the blood may be laked. The secretion of urine is stopped. Death usually results from respiratory paralysis, though, in case artificial respiration is maintained, death ensues from cardiac failure. Lafayette B. Mendel communicates four brief contributions to physiological chemistry from the Sheffield Laboratory of Yale University. In the first of the papers Professor Mendel gives an analysis of three species of West Indian corals examined for iodine and declares that for many organisms iodine is as essential an element as is chlorine for others. The second paper, 'Glycogen formation after inulin feeding,' by R. Nakaseko, concludes with the statement that for the rabbit at least, the glycogen-forming properties of inulin must still be regarded as uncertain or minimal. G. A. Hanford's work on 'The influence of acids on the amylolytic action of saliva,' shows the impossibility of designating any percentage of acid or alkali which inhibits salivary digestion in a definite degree. The absolute amount of saliva and the attendant variation in the quantity of proteid matter present determine the character of the action. *Free* hydrochloric acid is certain to cause more or less complete inhibition of salivary action. The fourth contribution, by J. H. Goodman, 'On the connective tissue in muscle' is an account of experiments proving that the substance in muscle connective tissue described by Schepilewsky as mucin, is neither a glycoproteid nor a nucleoproteid, but resembles the *stroma substance* described by J. von Holmgren. B. Moore and W. H. Parker report a study of the effects of complete removal of the mammary glands on the formation of lactose. This research consists of an examination of the urine for sugar during gestation and at the time of parturition after complete extirpation of the mammary glands. If lactose be formed elsewhere than in the mammary glands it should appear in the blood at parturition and hence in the urine. The mammary glands of two goats were removed after several weeks of gestation. Parturition took place normally in both cases and the urine contained no reducing sugar. The authors believe that lactose is formed in the cells of the mammary gland and not from any intermediate substance carried to the gland by the blood.

DISCUSSION AND CORRESPONDENCE.

THE COPYRIGHT OF UNIVERSITY LECTURES.

To the Editor of Science: In commenting on the decision of the House of Lords in the *Times* v. Lane case, you say (Science, Aug. 24, p. 319), "Perhaps the lectures given to a class of students, * * * are not made public." On appeal from the Supreme Court of Scotland, this was, however, decided by the House of Lords just fifteen years ago, in the famous case of Caird v. Sime. Sime was a second-hand bookseller in Glasgow, who sold many text-books to the students of that University. He conceived the idea that he might turn a penny by getting the lectures of Edward Caird, professor of moral philosophy, then the most influential teacher in the University, and publishing them. He did so. The Scotch Courts decided against Caird, but on appeal to the House of Lords the decision was reversed, and a professor or lecturer was held to have his own copyright. It is curious to note, looking to the decision of the Scottish Court in the Caird case, that the minority in the *Times* case in the House of Lords was the Scottish member of the Court of Final Appeal. R. M. Wenley.

THE INTERNATIONAL PSYCHICAL INSTITUTE.

To the Editor of Science: Observing that my name figures in Bulletin No. 1, July, 1900, of the 'Institut Psychique International' as the member of the Council of Organization for America, I find myself compelled to state publicly that this appearance of my name is unauthorized. William James.

Nauheim, August 24, 1900.

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

It appears difficult to secure any information in regard to the French Association for the Advancement of Science. We have been unable to get programs by addressing the officers of the

Association, and the French Scientific Journals do not contain any regular announcements or reports of the meetings. The address of the President, General Sebert, before the Paris meeting is, however, published in several journals and the report of the Treasurer is printed in full in the *Revue Scientifique*.

M. Sebert reviewed the progress of mechanical science, and devoted the last third of his address to an international catalogue of scientific literature. It is rather curious that he does not in any way refer to the International Catalogue, but states that the problem is being solved by the Institut International de Biographie, established by MM. Lafontaine and Otlet in Brussels in 1895. The Dewey system of classification is adopted by them, and M. Sebert devotes a considerable part of his address to explaining the system which he advocates in warm terms.

The finances of the French Association are of interest. The capital amounts to 1,326,917 fr., chiefly due to legacies such as the American Association has never received. The income last year was about $17,000, of which nearly $7000 was income from the capital and about $10,000 represented the dues of members. These figures apparently are much more favorable than those of the American Association, in which the income from permanent funds was last year $233 and receipts from members $6216. It appears, however, that, owing to the cost of the volume of proceedings and of administration, the expenses of the French Association are considerably larger than the receipts from the annual dues of members, whereas, during the past two years, the American Association has been able to transfer to the permanent funds a portion of the dues received from members.

Although about half of the interest on the capital is used for current expenses, there is still a considerable sum—about $3000—which is annually awarded for the promotion of research. Among the larger grants made last year were: $300 to M. Giard for the publication of papers from the laboratory at Wimereux; $300 to M. Deniker for the publication of his book on the races of Europe; $240 to M. Lacaze-Duthiers towards repairing the steam-boat of the zoological laboratory at Arago, and $200 to M. Turpain for researches in telegraphy by Hertzian waves.

THE ELECTRICAL EFFECTS OF LIGHT UPON GREEN LEAVES.*

IN the preliminary communication recently made to the Royal Society, the author shows how, from the study of the electrical effects of light upon the retina, he was led to ask whether the chemical changes aroused by the action of light upon green leaves are also accompanied by electrical effects demonstrable in the same way as the eye currents. The question is tested in the following way: A young leaf freshly gathered is laid upon a glass plate and connected with a galvanometer by means of two unpolarizable clay electrodes *A* and *B*. The half of the leaf connected with *A* is shaded by a piece of black paper. An inverted glass jar forms a moist chamber to leaf and electrodes, which are then enclosed in a box provided with a shuttered aperture through which light can be directed. A water trough in the path of the light serves to cut out heat more or less. Under favorable conditions there is obtained with such an arrangement a true electrical response to light, consisting in the establishment of a potential difference between illuminated and non-illuminated half of a leaf, amounting to 0.02 volt.

The deflection of the galvanometer spot during illumination is such as to indicate current in the leaf from excited to protected part. The deflection begins and ends sharply with the beginning and end of illumination; it is provoked slightly by diffuse daylight, more by an electric arc-light, most by bright sunlight. It is abolished by boiling the leaf, and by the action of an anæsthetic, carbon dioxide.

The first experiments, made at the end of March, were upon iris leaves taken from plants about six inches high, and the response to light was then between 0.001 and 0.002 volt in value. Experiments upon similar leaves were resumed early in May, when it appeared that the external condition in which the state of the leaf is

* Abstract of a paper presented before the Royal Society by Augustus D. Waller, M.D., F.R.S., and published in *Nature*.

most obviously governed is *temperature*. On warm days the response ranged from 0.005 to 0.02 volt; on cold days it did not rise above 0.005, and was sometimes *nil*. Some tests upon leaves in a warmed box gave satisfactory results, which may thus be summed up: The normal response at 15°–20° C. is diminished or abolished at low temperature (10°) augmented at high temperature (30°), diminished at higher temperature (50°), and abolished by boiling.

As the month of May advanced, the iris leaves, even in the warm box, became more and more inert, and by the 23d inst., when the plants were mostly full grown and in flower, no satisfactory leaf could be found. Leaves of iris appear to give more marked response at or about mid-day, than at or about 6 p. m. Tested by Sach's method the leaves give no evidence of starch activity during isolation.

On the failure of the iris leaves to react, other leaves were sought for which should give evident differences of reaction in correlation with evident differences of state. Leaves of tropæolum and of mathiola gave a response to light contrary in the main to the ordinary iris response, viz, 'positive' during illumination, and subsequently 'negative.' In these two cases leaves empty of starch acted better than leaves laden with starch. Leaves of begonia gave a variety of responses strongly suggestive of the simultaneous action of two opposed forces effecting a resultant deflection in a + or — direction. Leaves of ordinary garden shrubs and trees, etc., *e. g.*, lilac, pear, almond, mulberry, vine, ivy, gave no distinct response; this is possibly due to a lower average metabolism in such leaves as compared with the activity of leaves of small young plants in which leaf-functions are presumably concentrated within a smaller area. The petals of flowers gave no distinct response, which indicates that chloroplasts are essential to the reaction.

The effect of carbon dioxide upon the iris leaf was abolition of response during and after passage of the gas, with subsequent augmentation. Upon mathiola and trapæolum, augmentation of response followed on applying air containing 1 to 3 per 100 of carbon dioxide, and prompt abolition resulted from a full stream run through the leaf-chamber. On the air supply being kept clear of carbon dioxide there was gradual abolition of response, followed by gradual recovery on the re-admission of a small amount of carbon dioxide.

'Fatigue' effects may be produced if the successive illuminations (of five minutes duration) are repeated at short intervals (10 minutes). At intervals of one hour, successive illuminations of five minutes produce approximately equal effects. With the leaf of mathiola, periods of illumination of two minutes at intervals of 15 minutes were used without provoking any obvious sign of fatigue.

SCIENCE RESEARCH SCHOLARSHIPS.

THE Commissioners for the Exhibition of 1851, as we learn from the London *Times*, have made the following appointments to Science Research Scholarships for the year 1900 on the recommendation of the authorities of the respective universities and colleges. The scholarships are of the value of £150 a year, and are ordinarily tenable for two years (subject to a satisfactory report at the end of the first year) in any university at home or abroad, or in some other institution approved of by the Commissioners. The scholars are to devote themselves exclusively to study and research in some branch of science, the extension of which is important to the industries of the country. A limited number of the scholarships are renewed for a third year where it appears that the renewal is likely to result in work of scientific importance.

Nominating Institution.	Scholar.
University of Edinburgh . .	Charles E. Fawsitt, B.Sc.
University of Glasgow......	Vincent J. Blyth, M.A.
University of Aberdeen.....	James Moir, M.A., B.Sc.
Yorkshire College, Leeds...	William M. Varley, B.Sc.
University Coll., Liverpool..	John C. W. Humfrey, B.Sc.
University College, London	Samuel Smiles, B.Sc.
Owens College, Manchester.	Norman Smith, B.Sc.
Univ. Coll., Nottingham....	Lorenzo L. Lloyd.
Univ. Coll. of South Wales and Monmouthshire, Cardiff......................	Alice L. Embleton, B.Sc.
Royal Coll. Science, Dublin.	John A. Cunningham, B.A.
Queen's College, Galway....	William S. Mills, B.A.
University of Toronto.	John Patterson, B.A.
Queens University, Kingston, Ontario............ ...	William C. Baker, A.M.
Dalhousie University, Halifax, Nova Scotia...........	James Barnes, M.A.
University of Sydney........	John J. E. Durack, B.A.

The following scholarships granted in 1898 and 1899 have been continued for a second year on receipt of a satisfactory report of work done during the first year:

Nominating Institution.	Scholar.	Place of Study.
Univ. St. Andrews..	J. C. Irvine, B.Sc.	Univ. of Leipzig.
Mason Univ. Coll., Birmingham.	Henry L. Heathcote, B.Sc.	Univ. of Leipzig.
Univ. Coll., Bristol.	Winif. E. Walker, B.Sc.	Univ. Coll., London.
Yorkshire College, Leeds.	Fred. W. Skirrow, B.Sc.	Univ. of Leipzig.
Univ. Coll., Liverpool.	Charles G. Barkla, B.Sc.	Cavendish Lab., Cambridge.
Univ. Coll., London	Harriette Chick, B.Sc.	Thompson-Yates Lab., Univ. Coll., Liverpool.
Owens Coll., Manchester.	Frank A. Lidbury, B.Sc.	Univ. of Leipzig.
Durham Coll. Sci., Newcastle-upon-Tyne.	William Campbell, B.Sc.	Royal Coll. of Sci., S. Kensington.
Univ. Coll., Nottingham.	Louis Lownds, B.Sc.	Univ. of Berlin.
Univ. Coll. Wales, Aberystwith.	James T. Jenkins, B.Sc.	Univ. of Kiel and Biol. Institution, Heligoland.
Univ. Coll. of North Wales, Bangor.	Robert D. Abell, B.Sc.	Univ. of Leipzig.
Queens Coll., Belfast.	William Caldwell, B.A.	Univ. Würzburg.
McGill Univ., Montreal.	William B. McLean, B.Sc.	Owens Coll., Manchester.
Univ. of Melbourne	Bertram D. Steele, B.Sc.	Univ. of Breslau.
Queen's Coll., Cork.	Ed. J. Butler, M.B.	Univ. of Freiburg.
Univ. of New Zealand.	Joseph W. Mellor, B. c.	Owens Coll., Manchester.
Univ. Coll., London	Louis N. G. Filon, M.A.	King's Coll., Cambridge.

The following scholarships granted in 1898 have been exceptionally renewed for a third year:

Nominating Institution.	Scholar.	Place of Study.
Mason Univ. Coll., Birmingham.	A. H. H. Buller, B.Sc., Ph.D.	Univ. of Munich.
Yorkshire College, Leeds.	Harry T. Calvert, B.Sc.	Univ. of Leipzig.
Royal Coll. of Sci., Dublin.	Rob. L. Wills, B.A.	Cavendish Lab., Cambridge.
Dalhousie Univ., Halifax, N. S.	Eben. H. Archibald, M.Sc.	Harvard Univ.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR A. MICHELSON, of the University of Chicago, has been awarded the grand prize of the Paris Exposition for his Echelon spectroscope.

IT is reported that Professor Haeckel, of Jena, is about to start for Java to conduct explorations in search of *Pithecanthropus erectus.*

IN the matter of the vacancy arising from the death of Professor James E. Keeler, the president and board of regents of the University of California have authorized astronomer W. W. Campbell to discharge the duties of the director of the Lick Observatory, *ad interim.*

M. M. OUSTALET and DEPOUSARQUES have been nominated by the Paris Academy of Sciences for the chair of zoology in the Muséum d'Histoire naturelle, rendered vacant by the death of Professor Milne-Edwards. One of these candidates will be selected by the minister of public instruction.

MR. THOMAS LARGE has been appointed assistant in charge of the Fresh Water Biological Station of the University of Illinois, at Meredosia, Illinois, to succeed Dr. C. A. Kofoid, who, as we have already announced, has accepted a call to the University of California.

MR. J. STIRLING, Government geologist of Victoria, is at present in London, and will address several scientific societies during his stay in England.

SURGEON A. R. THOMAS of the U. S. Marine Hospital Service has been sent to Glasgow to investigate the bubonic plague which appears to be increasing in that city.

THE Government of Queensland has engaged Dr. Maxwell, the sugar expert of Honolulu, for five years' service on the Food Commission at a salary of $20,000 a year.

DR. F. ROEMER, assistant in the Zoological Institute at Breslau, has been made curator in the Senckenbergischen Museum at Frankfurt-on-the-Main.

PROFESSOR K. LAMPERT, of Stuttgart, has been made curator of the Royal Natural History collections.

DR. D. MORRIS, the British Commissioner of Agriculture for the West Indies, is at present in Great Britain for the purpose of reporting to the Colonial office.

DR. C. VIRCHOW has been appointed chemist in the geological bureau at Berlin.

THE tomb of Sir Humphrey Davy, at Geneva, which for some years was in a neglected state, has recently been renovated.

DR. JOHN ANDERSON, M.D., F.R.S., has died at Buxton at the age of 66 years. He was appointed superintendent of the Indian Museum, Calcutta, in 1865, and made several expeditions to China. He was the author of numerous and important contributions to zoology and the literature of scientific explorations.

We regret to learn of the death of Professor Henry Sidgwick, who was recently compelled by ill health to resign the professorship of moral philosophy at Cambridge University. Professor Sidgwick was born in Yorkshire on May 31, 1838, and was educated at Rugby and Trinity College. He was elected a fellow of Trinity College, but resigned owing to the religious tests then imposed. He was, however, elected an honorary fellow of Trinity in 1881, and in 1883 became Knightbridge professor of moral philosophy. Professor Sidgwick published numerous and important books on ethical and economic subjects which united in a rare degree genius and scientific caution.

Friedrich Wilhelm Nietzsche, the philosopher and man of letters, died on August 25th at Weimar, where for eleven years he had been living hopelessly insane at the home of his sister. Nietzsche was formerly professor of oriental languages at Bâsle, but later gave this up to travel and to write his remarkable books which showed genius of a destructive rather than of a constructive character. They are of interest to men of science, because he was greatly influenced by modern theories of biological evolution.

The death is announced of Sir John Bennett Lawes, F.R.S., at the age of 86 years. He was educated at Eton and Oxford, and early began the study of scientific agriculture, being one of the first to use bone dressing and artificial fertilizers. He was the author of over one hundred papers on the scientific aspects of agriculture.

Sir Malcolm Fraser, a civil engineer, formerly Surveyor-general and Colonial Secretary of Western Australia, died at Clifton on August 17th, aged 66 years.

The Fourth International Congress of Psychology opened at Paris on August 20th with an attendance of about 400 and a long list of papers on its program. The first general addresses were given by M. Ribot, professor in the Collège de France and Professor Ebbinghaus of Breslau. Among the Americans in attendance were Professor Ladd of Yale University, Professor Münsterberg of Harvard University, Professor Bryan of the University of Indiana, and Professor Warren of Princeton University.

The annual meeting of the English Arboricultural Society, says *Nature*, was held at Manchester recently. Professor Somerville was appointed president for the ensuing year. Reports were read from the judges upon essays on 'Foreign *versus* Native Timber,' 'Agricultural and Woodland Drainage,' and 'Thinning.' The silver medal for the first essay was awarded to Mr. George Cadell, late of the Indian Forest Department, and bronze medals for the other essays were given to Mr. D. A. Glen, of Kirby, near Liverpool, and Mr. A. Dean, of Egham.

The Governing Body of the Jenner Institute announce their intention of awarding three studentships of £150 each, tenable by British subjects for one year from January 1st next, and renewable for a second year at the option of the Governing Body, for the purposes of research at the Institute. Applications from candidates must be sent in by November 1st.

The Berlin Academy of Sciences offers its prize on the Steiner foundation for the solution of some important problem connected with the theory of curved surfaces, preferably related to the work of Steiner. The prize is of the value of 4000 Marks with a second prize of 2000 Marks. The paper must be handed in by the end of the year 1904, and may be written in English.

Major Gibbons has reached Omdurman after a trip through Africa extending to about 13,000 miles. Among the objects attained were the mapping of Marotseland, 200,000 miles in area; the accomplishment of the first steam navigation of the Middle Zambesi, and the tracing of the whole course of the river, the discovery of its source and the determination of its watershed. Thence the route of the expedition was eastward and by way of the Great Lakes to the Nile. It is understood that Major Gibbons has brought with him valuable collections.

During the summer the Ohio State Archæological and Historical Society, under the direction of the curator, Wm. C. Mills, carried on explorations at the Baum prehistoric village site, near Bourneville, Ross County, Ohio. The work was very successful; more than 60 skeletons were found and photographed in place. This village site is especially rich in fine implements of bone, shell and stone, of which several thousand were taken from the ash pits together with the bones of the elk, deer, bear, wolf, raccoon, wild turkey and Indian dog.

THE French Minister of War, as we learn from *Nature*, has invited the Paris Academy of Sciences to advise as to the precautions to be adopted in selecting and planting trees in the neighborhood of powder magazines, in order to secure the best protection from lightning.

THE United States Civil Service Commission announces that it has been informed by the Department of Agriculture that there is an opportunity at this time for appointment to two or three positions in the office of Public Road Inquiries of persons qualified as practical road builders and who have a knowledge of rural engineering, geology, mineralogy, and kindred subjects. Persons who desire to become eligible will not be required to appear at any place for examination but should file with the Commission a properly certified statement as to the length of time spent in college, the studies pursued, the standing in those studies, and the special qualifications they have for such work mentioned above together with a thesis upon the subject mentioned, or in lieu of this thesis literature upon this subject published over their own signatures. At the request of the Department applications will not be accepted from other than graduates of colleges receiving the benefits of grants of land or money from the United States. The length of time any scientific aid may serve in the Department is limited to two years. The salary shall not exceed $40 per month. The subjects and weights of this examination will be as follows:

Subjects.	Weights.
1. College course with bachelor's degree	50
2. Post-graduate course and special qualifications	25
3. Thesis or other literature	25
Total	100

A REMARKABLE meteor is reported by observers in New England. As seen from the mouth of the Damariscotta River, Maine, its altitude, when, at 8 P. M., it burst into view, was about thirty degrees and its direction north by west, color a rich copper green, and magnitude and brilliancy so great as to light up the whole country with a flash of great intensity, the light persisting about two seconds before final extinction. The mass was pear-shaped, larger end downward. The smaller end shaded from green to yellow. A little later, a bright red meteorite was seen north by west of smaller size. We hope that our correspondents will supply more precise data.

DETAILS have been published in regard to the plague at Hong-Kong which show that the epidemic has not been quite so severe this year as last, and is now abating somewhat. The deaths during the past six years have varied in a curious way, being as follows: 1894, 2485, 1895, 36; 1896, 1078; 1897, 19; 1898, 1175; 1899, 1428. The deaths are chiefly among the Chinese, the mortality being excessive—perhaps in part due to the fact that cases which did not result fatally were not reported. Last year the total number of cases was 1455, and the number of deaths 1407.

THE fastest regular trains in the world are, as we have already noted, those running over the Philadelphia and Reading and Pennsylvania Railroad from Camden to Atlantic City. By the former line the 55½ miles is traversed at the rate of 66.6 per hour. The Empire State Express, of the New York Central Railroad, however, no longer holds the record for long distance trains. It runs from New York to Buffalo—440 miles—at the rate of 53.33 miles per hour. The Sud Express on the Orleans and Midi Railway now runs from Paris to Bayonne, a distance of 486¼ miles, at the rate of 54.13 miles per hour.

THE London *Daily Graphic*, as quoted in *Nature*, states that the Norwegian government has built and fitted out a steam vessel for the express purpose of marine scientific research, and has placed her, as well as a trained staff of assistants, in charge of Dr. J. Hjort as leader of the Norwegian Fishery and Marine Investigations. The vessel herself, the *Michael Sars*, has been constructed in Norway on the lines of an English steam trawler—that type of boat being regarded as the most seaworthy and suitable for such an expedition—but considerably larger, being 132 feet in length, 23 feet beam, and fitted with triple expansion engines of 300 horse-power. The fishing gear includes, *inter alia*, trawls, nets, and lines of all kinds, with massive steel hawsers and powerful steam winches to work the heavy apparatus, while the numerous scientific instruments are of the very best and latest description. The expedition left Christiana in the middle of July, on what may be termed its trial trip along the Norwegian coast (accompanied for part of the time by Dr. Nansen, who was desirous of testing various instruments in which he had made improvements), and has just sailed from Tromsö on a lengthy cruise to the North Atlantic and Arctic Oceans. Dr. Hjort has already added so much to the knowledge of pelagic fishes, their life, habits, and the causes affecting their migrations, that, with the means now at his disposal, a considerable amount of valuable information will probably be gained which will prove of service to the fishing industry of all nations.

The Queen Regent of Spain has signed a decree establishing the method of accounting time in the kingdom as follows:

(1) In all railway, mail (including telegraph), telephone, and steamship service in the Peninsula and the Ballearic Islands, and in all the ministerial offices, the courts, and all public works, time shall be regulated by the time of the Greenwich Observatory, commonly known as western European time.

(2) The computation of the hours in the above-mentioned services will be made from the hour of midnight to the following midnight in hours from 1 to 24, omitting the words tarde (afternoon) and noche (night), heretofore in customary use.

(3) The hour of midnight will be designated as 24.

(4) The interval, for instance, between midnight (24) and 1 o'clock will be designated as 0.05, 0.10, 0.59.

The report of the Zoological Gardens of Ghizeh, near Cairo, for the year 1899 is summarized in *Nature*. Under its present director, Captain Stanley Flower, it has become a popular place of resort for the European visitors to Egypt, as well as for the Cairenes. The receipts for 1899 were 3033*l*., of which 968*l*. were for gate-entrances, and the expenditure was 3019*l*. The list of donors includes many well-known names, amongst them those of Sir William Garstin, Prince Omar Tousson, Sir F. Wingate and Lord Kitchener. The government of India presented an elephant. Various new buildings were erected, and others were reconstructed in 1899. The number of animals in the collection on October 1st of that year was 473, against 270 at the corresponding date in 1898. A list of wild birds that inhabit the Ghizeh Gardens, and in many cases breed there, enumerates nineteen species, amongst which is the European song-thrush (*Turdus musicus*). Two proboscis monkeys (*Nasalis larvatus*), presented by the government of the Netherlands, East Indies, unfortunately did not live long. Since the report was issued Captain Flower has succeeded in bringing to the Ghizeh Gardens from the Sudan a fine young giraffe, presented by the Sirdar.

A correspondent writes to the London *Times*: At this week's meeting of the Royal Horticultural Society a fruit was exhibited for the first time which bids fair to become very useful. From a botanical point of view also it is of considerable interest, the plant bearing it being a hybrid between the raspberry and the common blackberry. As the 'Mahdi,' as it has been called, was raised by Messrs. Veitch, its origin is well authenticated, the seed parent being a variety of the raspberry known as 'Belle de Fontenay.' The same cannot be said for the Logan berry trailing from the other side of the Atlantic, for which a somewhat similar parentage has been claimed. A high authority, however, is of opinion that the raspberry plays no part in its composition, and that both its parents were an American species of *Rubus* instead of only one. The 'Mahdi' has very much the habit of the blackberry, and in cultivation it is trained in the same way. Its fruit recalls to some extent the dewberry of our hedges. There is the same bloom, but the number of fruitlets is greater. Careful scrutiny will reveal many intermediate characters; the taste of the 'berry' combines a preponderant flavor of the dewberry with a suspicion of that of the raspberry. Most important is the time of fruiting as regards the future of the plant economically, for it comes into bearing as the raspberries are failing and before the blackberries are ripe. The 'Mahdi' is very prolific and has considerable claims to be a decorative plant; it will not, however, be placed upon the market for probably another twelve months at least.

A summary of the work done by the Reichsanstalt from February, 1899, to February, 1900, has been published in the *Zeitschrift für Instrumentenkunde*. According to an abstract in the *Electrical World* the comparison of the two sets of standard resistance coils showed good agreement; the variations during seven years amount only to a few hundred thousandths of the original value. Preliminary experiments were made for determining the capacity of an air condenser. A greater number of zinc and cadmium standard cells were made for testing purposes; renewed measurements gave results in good agreement with the figures published last year. The exact investigation of the conductivity of aqueous solutions has been concluded for the chlorides and nitrates of alkaline metals. The instruments, storage batteries, primary cells, cut-outs, insulating and conducting materials, arc lamp carbons, fuses which have been tested, are given in a table. Statistical material on the use of electric meters in practice has been collected; according to the information given by the central stations, about 60,000 meters are at present in use in Germany, while about twice as many is the number estimated by the manufacturers. The apparatus for testing alternating current instruments was completed. A new resistance material of Heraeus was tested, the investigation of the resistance devised by Kundt was continued. One hundred and eleven Clark and 22 Weston cells were tested. The variation from the normal e. m. f. was below 0.0003 volt for 83 Clark cells, between 0.0004 and 0.0006 volt for 23 cells, 0.001 volt for 1 cell and greater than 0.001 volt for 4 cells. The agreement of the commercial Weston cells was found to be very satisfactory. The magnetic properties of 25 samples of steel and iron were tested. An investigation was made of the difference between continuous and interrupted magnetization. Also preliminary measurements were made to investigate the influence of repeated annealing upon the magnetic properties of different samples of iron.

Some of our Consuls in South America, says the London *Times*, refer in their last reports to the virtues ascribed to the tea made from yerba maté, a herb which takes the place to some extent of tea and coffee, and which is derived from the leaves of the *Ilex Poraguariensis*, a tree of from twelve to twenty feet in height. The Consul in Paraguay says this tea is consumed by a large proportion of the populations of Brazil, the Argentine, Uruguay, Chili and Paraguay. The leaves are gathered every two or three years and dried over a slow fire; they are then pounded in mortars in the ground, and finally packed in fresh skins and dried in the sun. The tea is made by pouring boiling water on the leaves, which serve for several infusions. The taste is bitter, but not unpleasant, and the effects are asserted to be invigorating. It is said that it would be valuable as a restorative to troops on the march and on active service, and the French Government have ordered a shipment of maté for the colonial troops and some samples have also been sent to Germany for experimental purposes. An attempt is also being made to introduce it into the United States as a suitable beverage for the working classes. When analyzed the tea is shown to contain caffeine and cafetannic acid in important proportions. The Council-General at Rio also refers to the subject as one of commercial interest. It is claimed, he says, on behalf of the tea that it possesses superior stomachic properties to tea and coffee, in that, while it is refreshing and invigorating and favorable alike to mental and physical exertion, it does not disturb the nervous system. But even Brazilians are not agreed as to its merits, some alleging that by its aid the most arduous work can be done, such as forced marches of troops on short rations; others asserting that in war coffee has proved much more sustaining. However this may be, it is largely consumed in South American countries when the prices of low grade China teas are too high to admit of their shipment to South

America, and it is therefore possible that it has some good qualities to recommend it.

The South African Native Races Committee have, as we learn from the London *Times*, addressed a letter to the Colonial Secretary submitting certain points for his consideration on which they believe that there is need for an inquiry connected with the black and colored population of South Africa. It is stated that no recent public investigation into this subject has been made. Even with regard to Cape Colony and Natal the time seems to have come for further inquiry with reference to many points of importance, such as the overcrowding of locations; the provision of land for surplus population; the practical effect of the Glen Grey act; the working of the Pass Laws; the question of native education, and other matters. In other parts of British South Africa the need for a thorough investigation of native questions is still greater. The committee urge on her majesty's government the expediency of inquiries being instituted at as early a date as possible, with regard to some at least of the following matters: (1) Laws, customs, and land tenure of the natives in districts which were not the subject of examination by the Cape Government Commission; (2) the operation of the existing tribal system, and the expediency of maintaining it; (3) the advisability of setting aside large areas (such as the whole or part of the Zoutpansberg district and Swaziland) to be administered for the exclusive use and benefit of the native tribes; (4) the condition of existing native locations and reserves, the terms upon which lands are secured to the natives, and the need and method of providing further lands for the surplus native population; (5) the provision of further facilities for the flow of labor to centers of industry, and, if practicable, for the migration of families to such centers, the supervision of contracts of service, the securing of safe and healthy conditions of labor in the mines and other occupations; (6) the provision of advice and assistance for natives at industrial centers, and of facilities for the deposit and transmission of their earnings; (7) the need for further Government aid for native education and for reforms in the present system; (8) the effects of existing methods of taxation on the economic and social condition of the natives; (9) the working of the Pass Laws, with a view to ascertaining whether their mitigation or abolition is practicable; (10) the administration of the Liquor Laws.

UNIVERSITY AND EDUCATIONAL NEWS.

The fact that under the new constitution of the University of London the registered graduates have a larger share than before in the government of the University has led to the formation of the University of London Graduates Union. Dr. K. P. H. Pye-Smith, F.R.S., has been elected president.

President Charles F. Thwing, of Western Reserve University, Cleveland, is at present delivering a course of lectures at the University of Virginia on 'The American University,' treating its organization and administration, its chief executive, the university and patriotism, and the place of the university in American life.

Dr. George P. Dreyer, Ph.D. (Johns Hopkins), associate professor of physiology in the Johns Hopkins Medical School, has been elected professor in charge of the physiological department of the College of Physicians and Surgeons (Chicago), the medical department of the University of Illinois.

The vacancy in the chair of mathematics in Haverford College caused by the removal of Dr. Frank Morley to Johns Hopkins University has been filled by the appointment of Dr. A. W. Reid, A.B. (Johns Hopkins) Ph.D. (Göttingen), instructor in mathematics at Princeton University. The vacancy at Princeton has been filled by the appointment of Dr. L. P. Eisenhart who received this year the doctorate at the Johns Hopkins University.

Dr. Th. Ziehen, associate professor of psychiatry in the university at Jena, has been appointed professor in the University of Utrecht.

We notice also the following appointments in foreign universities: Dr. Pfeiffer professor of agricultural chemistry in the university at Jena has been called to Breslau; Professor P. Curie, of Paris, has been appointed professor of general and experimental physics in the University at Geneva; Dr. Zehander, has qualified as docent in physics in the university at Munich.

SCIENCE

Friday, September 14, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

ADDRESS OF THE PRESIDENT BEFORE THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

II.

FUNCTION OF CELLS.

It has already been stated that, when new cells arise within pre-existing cells, division of the nucleus is associated with cleavage of the cell plasm, so that it participates in the process of new cell-formation. Undoubtedly, however, its *rôle* is not limited to this function. It also plays an important part in secretion, nutrition, and the special functions discharged by the cells in the tissues and organs of which they form morphological elements.

Between 1838 and 1842 observations were made which showed that cells were constituent parts of secreting glands and mucous membranes (Schwann, Henle). In 1842 John Goodsir communicated to the Royal Society of Edinburgh a memoir on secreting structures, in which he established the principle that cells are the ultimate secreting agents; he recognized in the cells of the liver, kidney and other organs the characteristic secretion of each gland. The secretion was, he said, situated between the nucleus and the cell wall. At first he thought that, as the necleus was the reproductive organ of the cell, the secretion was formed in the interior of the cell by the agency of the cell wall; but three years later he regarded it as a product of the nucleus. The study of the process of spermatogenesis by his brother, Harry Goodsir, in which the head of the spermatozoon was found to correspond with the nucleus of the cell in which the spermatozoon arose, gave support to the view that the nucleus played an important part in the genesis of the characteristic product of the gland cell.

The physiological activity of the cell plasm and its complex chemical constitution soon after began to be recognized. Some years before Max Schultze had published his memoirs on the characters of protoplasm, Brücke had shown that the well-known changes in tint in the skin of the Chamæleon were due to pigment granules situated in cells in the skin which were sometimes diffused throughout the cells, at others concentrated in the center. Similar observations on the skin of the frog were made in 1854 by von Wittich and Harless. The movements were regarded as due to contraction of the cell wall on its contents. In a most interesting paper on the pigmentary system in the frog, published in 1858, Lord Lister demonstrated that the pigment granules moved in the cell plasma, by forces resident within the cell itself, acting under the influence of an external stimulant, and not by a contractility of the wall. Under some conditions the pigment was attracted to the center of the cell, when the skin became pale; under other conditions the pigment was diffused throughout the body and the branches of the cell, and gave to the skin a dark color. It was also experimentally shown that a potent influence over these movements was exercised by the nervous system.

The study of the cells of glands engaged in secretion, even when the secretion is colorless, and the comparison of their appearance when secretion is going on with that seen when the cells are at rest, have shown that the cell plasm is much more granular and opaque, and contains larger particles during activity than when the cell is passive; the body of the cell swells out from an increase in the contents of its plasm, and chemical changes accompany the act of secretion. Ample evidence, therefore, is at hand to support the position taken by John Goodsir, nearly sixty years ago, that secretions are formed within cells, and lie in that part of the cell which we now say consists of the cell plasm; that each secreting cell is endowed with its own peculiar property, according to the organ in which it is situated, so that bile is formed by the cells in the liver, milk by those in the mamma, and so on.

Intimately associated with the process of secretion is that of nutrition. As the cell plasm lies at the periphery of a cell, and as it is, alike both in secretion and nutrition, brought into closest relation with the surrounding medium, from which the pabulum is derived, it is necessarily associated with nutritive activity. Its position enables it to absorb nutritive material directly from without, and in the process of growth it increases in amount by interstitial changes and additions throughout its substance, and not by mere accretions on its surface.

Hitherto I have spoken of the cell as a unit, independent of its neighbors as regards its nutrition and the other functions which it has to discharge. The question has, however, been discussed, whether in a tissue composed of cells closely packed together cell plasm may not give origin to processes or threads which are in contact or continuous with corresponding processes of adjoining cells, and that cells may therefore, to some extent, lose their individuality in the colony of which they are members. Appearances were recognized between 1863 and 1870 by Schrön and others in the deeper cells of the epidermis and of some mucous membranes which gave sanction to this view, and it seems possible through contact or continuity of threads connecting a cell with its neighbors, that cells may exercise a direct influence on each other.

Nägeli, the botanist, as the foundation of a mechanico-physiological theory of descent, considered that in plants a network of cell plasm, named by him idioplasm, extended throughout the whole of the plant, forming its specific molecular constitution, and that growth and activity were regulated by its conditions of tension and movements (1884).

The study of the structure of plants with special reference to the presence of an intercellular network has for some years been pursued by Walter Gardiner (1882–97), who has demonstrated threads of cell plasm protruding through the walls of vegetable cells and continuous with similar threads from adjoining cells. Structurally, therefore, a plant may be conceived to be built up of a nucleated cytoplasmic network, each nucleus with the branching cell plasm surrounding it being a center of activity. On this view a cell would retain to some extent its individuality, though, as Gardiner contends, the connecting threads would be the medium for the conduction of impulses and of food from a cell to those which lie around it. For the plant cell, therefore, as has long been accepted in the animal cell, the wall is reduced to a secondary position, and the active constituent is the nucleated cell plasm. It is not unlikely that the absence of a controlling nervous system in plants requires the plasm of adjoining cells to be brought into more immediate contact and continuity than is the case with the generality of animal cells, so as to provide a mechanism for harmonizing the nutritive and other functional processes in the different areas in the body of the plant. In this particular, it is of interest to note that the epithelial tissues in animals, where somewhat similar connecting arrangements occur, are only indirectly associated with the nervous and vascular systems, so that, as in plants, the cells may require, for nutritive and other purposes, to act and react directly on each other.

NERVE CELLS.

Of recent years great attention has been paid to the intimate structure of nerve cells, and to the appearance which they present when in the exercise of their functional activity. A nerve cell is not a secreting cell; that is, it does not derive from the blood or surrounding fluid a pabulum which it elaborates into a visible, palpable secretion characteristic of the organ of which the cell is a constituent element, to be in due course discharged into a duct which conveys the secretion out of the gland. Nerve cells, through the metabolic changes which take place in them in connection with their nutrition, are associated with the production of the form of energy specially exhibited by animals which possess a nervous system, termed nerve energy. It has long been known that every nerve cell has a body in which a relatively large nucleus is situated. A most important discovery was the recognition that the body of every nerve cell had one or more processes growing out from it. More recently it has been proved, chiefly through the researches of Schultze, His, Golgi, and Ramon y Cajal, that at least one of the processes, the axon of the nerve cell, is continued into the axial cylinder of a nerve fiber, and that in the multipolar nerve cell the other processes, or dendrites, branch and ramify for some distance away from the body. A nerve fiber is therefore an essential part of the cell with which it is continuous, and the cell, its processes, the nerve fiber and the collaterals which arise from the nerve fiber collectively form a neuron or structural nerve unit (Waldeyer). The nucleated body of the nerve cell is the physiological center of the unit.

The cell plasm occupies both the body of the nerve cell and its processes. The intimate structure of the plasm has, by improved methods of observation introduced during the last eight years by Nissl, and conducted on similar lines by other investigators, become more definitely understood. It has been ascertained that it possesses two distinct characters which imply different structures. One of these stains deeply on the addition of certain dyes, and is named chromophile or chromatic substance; the other, which does not possess a similar property, is the achromatic network. The chromophile is found in the cell body and the dendritic processes, but not in the axon. It occurs in the form of granular particles, which may be scattered throughout the plasm, or aggregated into little heaps which are elongated or fusiform in shape and appear as distinct colored particles or masses. The achromatic network is found in the cell body and the dendrites, and is continued also into the axon, where it forms the axial cylinder of the nerve fiber. It consists apparently of delicate threads or fibrillæ, in the meshes of which a homogeneous material, such as is found in cell plasm generally, is contained. In the nerve cells, as in other cells, the plasm is without doubt concerned in the process of cell nutrition. The achromatic fibrillæ exercise an important influence on the axon or nerve fiber with which they are continuous, and probably they conduct the nerve impulses which manifest themselves in the form of nerve energy. The dendritic processes of a multipolar nerve cell ramify in close relation with similar processes branching from other cells in the same group. The collaterals and the free end of the axon fiber process branch and ramify in association with the body of a nerve cell or of its dendrites. We cannot say that these parts are directly continuous with each other to form an intercellular network, but they are apparently in apposition, and through contact exercise influence one on the other in the transmission of nerve impulses.

There is evidence to show that in the nerve cell the nucleus, as well as the cell plasm, is an effective agent in nutrition. When the cell is functionally active, both the cell body and the nucleus increase in size (Vas, G. Mann, Lugaro); on the other hand, when nerve cells are fatigued through excessive use, the nucleus decreases in size and shrivels; the cell plasm also shrinks, and its colored or chromophile constituent becomes diminished in quantity, as if it had been consumed during the prolonged use of the cell (Hodge, Mann, Lugaro). It is interesting also to note that in hibernating animals in the winter season, when their functional activity is reduced to a minimum, the chromophile in the plasm of the nerve cells is much smaller in amount than when the animal is leading an active life in the spring and summer (G. Levi).

When a nerve cell has attained its normal size it does not seem to be capable of reproducing new cells in its substance by a process of karyokinesis, such as takes place when young cells arise in the egg and in the tissues generally. It would appear that nerve cells are so highly specialized in their association with the evolution of nerve energy, that they have ceased to have the power of reproducing their kind, and the metabolic changes both in cell plasm and nucleus are needed to enable them to discharge their very peculiar function. Hence it follows that when a portion of the brain or other nerve-center is destroyed, the injury is not repaired by the production of fresh specimens of their characteristic cells, as would be the case in injuries to bones and tendons.

In our endeavors to differentiate the function of the nucleus from that of the cell plasm, we should not regard the former as concerned only in the production of young cells, and the latter as the exclusive agent in growth, nutrition, and, where gland cells are concerned, in the formation of their characteristic products. As regards cell reproduction also, though the process of division begins in the nucleus in its chromosome constituents, the achromatic figure in the cell plasm undoubtedly plays a part, and the cell plasm itself ultimately undergoes cleavage.

A few years ago the tendency amongst biologists was to ignore or attach but little importance to the physiological use of the nucleus in the nucleated cell, and to regard the protoplasm as the essential and active constituent of living matter; so much so, indeed, was this the case that independent organisms regarded as distinct species were described as consisting of protoplasm destitute of a nucleus; also that scraps of protoplasm separated from larger nucleated masses could, when isolated, exhibit vital phenomena. There is reason to believe that a fragment of protoplasm, when isolated from the nucleus of a cell, though retaining its contractility and capable of nourishing itself for a short time, cannot increase in amount, act as a secreting structure, or reproduce its kind: it soon loses its activity, withers and dies. In order that these qualities of living matter should be retained, a nucleus is by most observers regarded as necessary (Nussbaum, Gruber, Haberlandt, Korschelt), and for the complete manifestations of vital activity both nucleus and cell plasm are required.

BACTERIA.

The observations of Cohn, made about thirty years ago, and those of De Bary shortly afterwards, brought into notice a group of organisms to which the name 'bacterium' or 'microbe' is given. They were seen to vary in shape: some were rounded specks called cocci, others were straight rods called bacilli, others were curved or spiral rods, vibrios or spirillæ. All were characterized by their extreme minuteness, and required for their examination the highest powers of the best microscopes. Many bacteria measure in their least diameter not more than $\frac{1}{25000}$th of an inch, $\frac{1}{10}$th the diameter of a human white blood corpuscle. Through the researches of Pasteur, Lord Lister, Koch, and other observers, bacteria have been shown to play an important part in nature. They exercise a very remarkable power over organic substances, especially those which are complex in chemical constitution, and can resolve them into simpler combinations. Owing to this property, some bacteria are of great economic value, and without their agency many of our industries could not be pursued; others again, and these are the most talked of, exercise a malign influence in the production of the most deadly diseases which afflict man and the domestic animals.

Great attention has been given to the structure of bacteria and to their mode of propagation. When examined in the living state and magnified about 2000 times, a bacterium appears as a homogeneous particle, with a sharp definite outline, though a membranous envelope or wall, distinct from the body of the bacterium, cannot at first be recognized; but when treated with reagents a membranous envelope appears, the presence of which, without doubt, gives precision of form to the bacterium. The substance within the membrane contains granules which can be dyed with coloring agents. Owing to their extreme minuteness it is difficult to pronounce an opinion on the nature of the chromatine granules and the substance in which they lie. Some observers regard them as nuclear material, invested by only a thin layer of protoplasm, on which view a bacterium would be a nucleated cell. Others consider the bacterium as formed of protoplasm containing granules capable of being colored, which are a part of the protoplasm, itself, and not a nuclear substance. On the latter view, bacteria would consist of cell plasm enclosed in a membrane and destitute of a nucleus. Whatever be the nature of the granule-containing material, each bacterium is regarded as a cell, the minutest and simplest living particle capable of an independent existence that has yet been discovered.

Bacteria cells, like cells generally, can produce their kind. They multiply by simple fission, probably with an ingrowth of the cell wall, but without the karyokinetic phenomena observed in nucleated cells. Each cell gives rise to two daughter cells, which may for a time remain attached to each other and form a cluster or a chain, or they may separate and become independent isolated cells. The multiplication, under favorable conditions of light, air, temperature, moisture and food, goes on with extraordinary rapidity, so that in a few hours many thousand new individuals may arise from a parent bacterium.

Connected with the life-history of a bacterium cell is the formation in its substance, in many species and under certain conditions, of a highly refractile shiny particle called a spore. At first sight a spore seems as if it were the nucleus of the bacterium cell, but it is not always present when multiplication by cleavage is taking place, and when present it does not appear to take part in the fission. On the other hand, a spore, from the character of its envelope, possesses great power of resistance, so that dried bacteria, when placed in conditions favorable to germination, can through their spores germinate and resume an active existence. Spore formation seems, therefore, to be a provision for continuing the life of the bacterium under conditions which, if spores had not formed, would have been the cause of its death.

The time has gone by to search for the origin of living organisms by a spontaneous aggregation of molecules in vegetable or other infusions, or from a layer of formless primordial slime diffused over the bed of the ocean. Living matter during our epoch has been, and continues to be, derived from pre-existing living matter, even when it possesses the simplicity of structure of a bacterium, and the morphological unit is the cell.

DEVELOPMENT OF THE EGG.

As the future of the entire organism lies in the fertilized egg cell, we may now briefly review the arrangements, consequent on the process of segmentation, which lead to the formation, let us say in the egg of a bird, of the embryo or young chick.

In the latter part of the last century, C. F. Wolff observed that the beginning of the embryo was associated with the formation of layers, and in 1817 Pander demonstrated that in the hen's egg at first one layer, called mucous, appeared, then a second or serous layer, to be followed by a third, intermediate or vascular layer. In 1828 von Baer amplified our knowledge in his famous treatise, which from its grasp of the subject created a new epoch in the science of embryology. It was not, however, until the discovery by Schwann of cells as constant factors in the structure of animals and in their relation to development that the true nature of these layers was determined. We now know that each layer consists of cells, and that all the tissues and organs of the body are derived from them. Numerous observers have devoted themselves for many years to the study of each layer, with the view of determining the part which it takes in the formation of the constituent parts of the body, more especially in the higher animals, and the important conclusion has been arrived at that each kind of tissue invariably arises from one of these layers and from no other.

The layer of cells which contributes, both as regards the number and variety of the tissues derived from it, most largely to the formation of the body is the middle layer or mesoblast. From it the skeleton, the muscles, and other locomotor organs, the true skin, the vascular system, including the blood, and other structures which I need not detail, take their rise. From the inner layer of cells or hypoblast, the principal derivatives are the epithelial lining of the alimentary canal and of the glands which open into it, and the epithelial lining of the air-passages. The outer or epiblast layer of cells gives origin to the epidermis or scarf skin and to the nervous system. It is interesting to note that from the same layer of the embryo arise parts so different in importance as the cuticle—a mere protecting structure, which is constantly being shed when the skin is subjected to the friction of a towel or the clothes—and the nervous system, including the brain, the most highly differentiated system in the animal body. How completely the cells from which they are derived had diverged from each other in the course of their differentiation in structure and properties is shown by the fact that the cells of the epidermis are continually engaged in reproducing new cells to replace those which are shed, whilst the cells of the nervous system have apparently lost the power of reproducing their kind.

In the early stage of the development of the egg, the cells in a given layer resemble each other in form, and, as far as can be judged from their appearance, are alike in structure and properties. As the development proceeds, the cells begin to show differences in character, and in the course of time the tissues which arise in each layer differentiate from each other and can be readily recognized by the observer. To use the language of von Baer, a generalized structure has become specialized, and each of the special tissues produced exhibits its own structure and properties. These changes are coincident with a rapid multiplication of the cells by cleavage, and thus increase in size of the embryo accompanies specialization of structure. As the process continues, the embryo gradually assumes the shape characteristic of the species to which its parents belonged, until at length it is fit to be born and to assume a separate existence.

The conversion of cells, at first uniform in character, into tissues of a diverse kind is due to forces inherent in the cells in each layer. The cell plasm plays an active though not an exclusive part in the specialization; for as the nucleus influences nutrition and secretion, it acts as a factor in the differentiation of the tissues. When tissues so diverse in character as muscular fiber, cartilage, fibrous tissues, and bone arise from the cells of the middle or mesoblast layer, it is obvious that, in addition to the morphological differentiation affecting form and structure, a chemical differentiation affecting composition also occurs, as the result of which a physiological differentiation takes place. The tissues and organs become fitted to transform the energy derived from the food into muscular energy, nerve energy, and other forms of vital activity. Corresponding differentiations also modify the cells of the outer and inner layers. Hence the study of the development of the generalized cell layers in the young embryo enables us to realize how all the complex constituent parts of the body in the higher animals and in man are evolved by the process of differentiation from a simple nucleated cell—the fertilized ovum. A knowledge of the cell and of its life-history is therefore the foundation-stone on which biological science in all its departments is based.

If we are to understand by an organ in the biological sense a complex body capable of carrying on a natural process, a nucleated cell is an organ in its simplest form. In a unicellular animal or plant such an organ exists in its most primitive stage. The higher plants and animals again are built up of multitudes of these organs, each of which, whilst having its independent life, is associated with the others, so that the whole may act in unison for a common purpose. As in one of your great factories each spindle is engaged in twisting and winding its own thread, it is at the same time intimately associated with the hundreds of other spindles in its immediate proximity, in the manufacture of the yarn from which the web of cloth is ultimately to be woven.

It has taken more than fifty years of hard and continuous work to bring our knowledge of the structure and development of the tissues and organs of plants and animals up to the level of the present day. Amidst the host of names of investigators, both at home and abroad, who have contributed to its progress, it may seem invidious to particularize individuals. There are, however, a few that I cannot forbear to mention, whose claim to be named on such an occasion as this will be generally conceded.

Botanists will, I think, acknowledge Wilhelm Hofmeister as a master in morphology and embryology, Julius von Sachs as the most important investigator in vegetable physiology during the last quarter of a century, and Strasburger as a leader in the study of the phenomena of nuclear division.

The researches of the veteran professor of anatomy in Würzburg, Albert von Kölliker, have covered the entire field of animal histology. His first paper, published fifty-nine years ago, was followed by a succession of memoirs and books on human and comparative histology and embryology, and culminated in his great treatise on the structure of the brain, published in 1896. Notwithstanding the weight of more than eighty years, he continues to prosecute histological research, and has published the results of his latest, though let us hope not his last, work during the present year.

Amongst our own countrymen, and belonging to the generation which has almost passed away, was William Bowman. His investigations between 1840 and 1850 on the mucous membranes, muscular fiber, and the structure of the kidney together with his researches on the organs of sense, were characterized by a power of observation and of interpreting difficult and complicated appearances which has made his memoirs on these subjects landmarks in the history of histological inquiry.

Of the younger generation of biologists Francis Maitland Balfour, whose early death is deeply deplored as a loss to British science, was one of the most distinguished. His powers of observation and philosophic perception gave him a high place as an original inquirer, and the charm of his personality—for charm is not the exclusive possession of the fairer sex—endeared him to his friends.

GENERAL MORPHOLOGY.

Along with the study of the origin and structure of the tissues of organized bodies, much attention has been given during the century to the parts or organs in plants and animals, with the view of determining where and how they take their rise, the order of their formation, the changes which they pass through in the early stages of development, and their relative positions in the organism to which they belong. Investigations on these lines are spoken of as morphological, and are to be distinguished from the study of their physiological or functional relations, though both are necessary for the full comprehension of the living organism.

The first to recognize that morphological relations might exist between the organs of a plant, dissimilar as regards their function, was the poet Goethe, whose observations, guided by his imaginative faculty, led him to declare that the calyx, corolla, and other parts of a flower, the scales of a bulb, etc., were metamorphosed leaves, a principle generally accepted by botanists, and indeed extended to other parts of a plant, which are referred to certain common morphological forms although they exercise different functions. Goethe also applied the same principle in the study of the skeletons of vertebrate animals, and he formed the opinion that the spinal column and the skull were essentially alike in construction, and consisted of vertebræ, an idea which was also independently conceived and advocated by Oken.

The anatomist who in our country most strenuously applied himself to the morphological study of the skeleton was Richard Owen, whose knowledge of animal structure based upon his own dissections, was unrivalled in range and variety. He elaborated the conception of an ideal, archetype vertebrate form which had no existence in nature, and to which, subject to modifications in various directions, he considered all vertebrate skeletons might be referred. Owen's observations were conducted to a large extent on the skeletons of adult animals, of the knowledge of which he was a master. As in the course of development modifications in shape and in the relative position of parts not unfrequently occur and their original character and place of origin become obscured, it is difficult, from the study only of adults, to arrive at a correct interpretation of their morphological significance. When the changes which take place in the skull during its development, as worked out by Reichert and Rathke, became known and their value had become appreciated, many of the conclusions arrived at by Owen were challenged and ceased to be accepted. It is, however, due to that eminent anatomist to state from my personal knowledge of the condition of anatomical science in this country fifty years ago, that an enormous impulse was given to the study of comparative morphology by his writings, and by the criticisms to which they were subjected.

There can be no doubt that generalized arrangements do exist in the early embryo which, up to a certain stage, are common to animals that in their adult condition present diverse characters, and out of which the forms special to different groups are evolved. As an illustration of this principle, I may refer to the stages of development of the great arteries in the bodies of vertebrate animals. Originally, as the observations of Rathke have taught us, the main arteries are represented by pairs of symmetrically arranged vascular arches, some of which enlarge and constitute the permanent arteries in the adult, whilst others disappear. The increase in size of some of these arches, and the atrophy of others, are so constant for different groups that they constitute anatomical features as distinctive as the modifications in the skeleton itself. Thus in mammals the fourth vascular arch on the left side persists, and forms the arch of the aorta ; in birds the corresponding part of the aorta is an enlargement of the fourth right arch, and in reptiles both arches persist to form the great artery. That this original symmetry exists also in man we know from the fact that now and again his body, instead of corresponding with the mammalian type, has an aortic arch like that which is natural to the bird, and in rarer cases even to the reptile. A type form common to the vertebrata does therefore in such cases exist, capable of evolution in more than one direction.

The reputation of Thomas Henry Huxley as a philosophic comparative anatomist rests largely on his early perception of, and insistence on, the necessity of testing morphological conclusions by a reference to the development of parts and organs, and by applying this principle in his own investigations. The principle is now so generally accepted by both botanists and anatomists that morphological definitions are regarded as depending essentially on the successive phases of the development of the parts under consideration.

The morphological characters exhibited by a plant or animal tend to be hereditarily transmitted from parents to offspring, and the species is perpetuated. In each species the evolution of an individual, through the developmental changes in the egg, follows the same lines in all the individuals of the same species, which possess therefore in common the features called specific characters. The transmission of these characters is due, according to the theory of Weismann, to certain properties possessed by the chromosome constituents of the segmentation nucleus in the fertilized ovum, named by him the germ plasm, which is continued from one generation to another, and impresses its specific character on the egg and on the plant or animal developed from it.

As has already been stated, the special tissues which build up the bodies of the more complex organisms are evolved out of cells which are at first simple in form and appearance. During the evolution of the individual, cells become modified or differentiated in structure and function, and so long as the differentiation follows certain prescribed lines the morphological characters of the species are preserved. We can readily conceive that, as the process of specialization is going on, modifications or variations in groups of cells and the tissues derived from them, notwithstanding the influence of heredity, may in an individual diverge so far from that which is characteristic of the species as to assume the arrangements found in another species, or even in another order. Anatomists had indeed long recognized that variations from the customary arrangement of parts occasionally appeared, and they described such deviations from the current descriptions as irregularities.

DARWINIAN THEORY.

The signification of the variations which arise in plants and animals had not been apprehended until a flood of light was thrown on the entire subject by the genius of Charles Darwin, who formulated the wide-reaching theory that variations could be transmitted by heredity to younger generations. In this manner he conceived new characters would arise, accumulate, and be perpetuated, which would in the course of time assume specific importance. New species might thus be evolved out of organisms originally distinct from them, and their specific characters would in turn be transmitted to their descendants. By a continuance of this process new species would multiply in many directions, until at length from one or more originally simple forms the earth would become peopled by the infinite varieties of plant and animal organisms which have in past ages inhabited, or do at present inhabit, our globe. The Darwinian theory may therefore be defined as Heredity modified and influenced by Variability. It assumes that there is an hereditary quality in the egg which, if we take the common fowl for an example, shall continue to produce similar fowls. Under conditions, of which we are ignorant, which occasion molecular changes in the cells and tissues of the developing egg, variations might arise, in the first instance probably slight, but becoming intensified in successive generations, until at length the descendants would have lost the characters of the fowl and have become another species. No precise estimate has been arrived at, and indeed one does not see how it is possible to obtain it, of the length of years which might be required to convert a variation, capable of being transmitted, into a new and definite specific character.

The circumstances which, according to the Darwinian theory, determined the perpetuation by hereditary transmission of a variety and its assumption of a specific character depended, it was argued, on whether it possessed such properties as enabled the plant or animal in which it appeared to adapt itself more readily to its environment, *i. e.*, to the surrounding conditions. If it were to be of use the organism in so far became better adapted to hold its own in the struggle for existence with its fellows and with the forces of nature operating on it. Through the accumulation of useful characters the specific variety was perpetuated by natural selection so long as the conditions were favorable for its existence, and it survived as being the best fitted to live. In the study of the transmission of variations which may arise in the course of development it should not be too exclusively thought that only those variations are likely to be preserved which can be of service during the life of the individual, or in the perpetuation of the species, and possibly available for the evolution of new species. It should also be kept in mind that morphological characters can be transmitted by hereditary descent, which, though doubtless of service in some bygone ancestor, are in the new conditions of life of the species of no physiological value. Our knowledge of the structural and functional modifications to be found in the human body, in connection with abnormalities and with tendencies or predisposition to diseases of various kinds, teaches us that characters which are of no use, and indeed detrimental to the individual, may be hereditarily transmitted from parents to offspring through a succession of generations.

Since the conception of the possibility of the evolution of new species from pre-existing forms took possession of the minds of naturalists, attempts have been made to trace out the lines on which it has proceeded. The first to give a systematic account of what he conceived to be the order of succession in the evolution of animals was Ernst Haeckel, of Jena, in a well-known treatise. Memoirs on special departments of the subject, too numerous to particularize, have subsequently appeared. The problem has been attacked along two different lines: the one by embryologists, of whom may be named Kowalewsky, Gegenbaur, Dohrn, Ray Lankester, Balfour and Gaskell, who with many others have conducted careful and methodical inquiries into the stages of development of numerous forms belonging to the two great divisions of the animal kingdom. Invertebrates, as well as vertebrates, have been carefully compared with each other in the bearing of their development and structure on their affinities and descent, and the possible sequence in the evolution of the Vertebrata from the Invertebrata has been discussed. The other method pursued by paleontologists, of whom Huxley, Marsh, Cope, Osborn and Traquair are prominent authorities, has been the study of the extinct forms preserved in the rocks and the comparison of their structure with each other and with that of existing organisms. In the attempts to trace the line of descent the imagination has not unfrequently been called into play in constructing various conflicting hypotheses. Though from the nature of things the order of descent is, aud without doubt will continue to be, ever a matter of speculation and not of demonstration, the study of the subject has been a valuable intellectual exercise and a powerful stimulant to research.

We know not as regards time when the fiat went forth, 'Let there be Life, and there was Life.' All that we can say is that it must have been in the far-distant past, at a period so remote from the present that the mind fails to grasp the duration of the interval. Prior to its genesis our earth consisted of barren rock and desolate ocean.

When matter became endowed with life, with the capacity of self-maintenance and of resisting external disintegrating forces, the face of nature began to undergo a momentous change. Living organisms multiplied, the land became covered with vegetation, and multitudinous varieties of plants, from the humble fungus and moss to the stately palm and oak, beautified its surface and fitted it to sustain higher kinds of living beings. Animal forms appeared, in the first instance simple in structure, to be followed by others more complex, until the mammalian type was produced. The ocean also became peopled with plant and animal organisms, from the microscopic diatom to the huge leviathan. Plants and animals acted and reacted on each other, on the atmosphere which surrounded them and on the earth on which they dwelt, the surface of which became modified in character and aspect. At last Man came into existence. His nerve-energy, in addition to regulating the processes in his economy which he possesses in common with animals, was endowed with higher powers. When translated into psychical activity it has enabled him throughout the ages to progress from the condition of a rude savage to an advanced stage of civilization; to produce works in literature, art and the moral sciences which have exerted, and must continue to exert, a lasting influence on the development of his higher Being; to make discoveries in physical science; to acquire a knowledge of the structure of the earth, of the ocean in its changing aspects, of the atmosphere and the stellar universe, of the chemical composition and physical properties of matter in its various forms, and to analyze, comprehend and subdue the forces of nature.

By the application of these discoveries to his own purposes Man has, to a large extent, overcome time and space; he has studded the ocean with steamships, girdled the earth with the electric wire, tunneled the lofty Alps, spanned the Forth with a bridge of steel, invented machines and founded industries of all kinds for the promotion of his material welfare, elaborated systems of government fitted for the management of great communities, formulated economic principles, obtained an insight into the laws of health, the causes of infective diseases, and the means of controlling and preventing them.

When we reflect that many of the most important discoveries in abstract science and in its applications have been made during the present century, and indeed since the British Association held its first meeting in the ancient capital of your county sixty-nine years ago, we may look forward with confidence to the future. Every advance in science provides a fresh platform from which a new start can be made. The human intellect is still in process of evolution. The power of application and of concentration of thought for the elucidation of scientific problems is by no means exhausted. In science is no hereditary aristocracy. The army of workers is recruited from all classes. The natural ambition of even the private in the ranks to maintain and increase the reputation of the branch of knowledge which he cultivates affords an ample guarantee that the march of science is ever onwards, and justifies us in proclaiming for the next century, as in the one fast ebbing to a close, that Great is Science, and it will prevail.

WILLIAM TURNER.

ORIGINAL INVESTIGATIONS BY ENGINEERING SCHOOLS A DUTY TO THE PUBLIC AND TO THE PROFESSION.

The function of the modern university includes much more than the mere imparting of instruction to its students. In a newly recognized, important sense, the entire public must be considered university students, and by frequent publications, addressed to different classes of people, by extension lectures and possibly by correspondence instruction, the modern university must seek to educate this greater student body. Besides this no university, no department even, of a university can be considered to be doing living, vital work, unless in addition to its routine of instruction it is carrying on original investigations. Otherwise its work will be merely mechanical. No student can be properly educated without *bringing him* into such close contact with veiled truth that he feels the very throb of her pulse, and receives direct from her the inspiration to become himself a searcher after truth.

It is the object of this paper to make a plea that the function of the modern technical school should be, in its particular field, closely similar to that of the university, as outlined above. The author believes that in addition to educating engineers, the technical school should, by special courses supplying special equipment, train leaders for all the industrial and commercial work of modern civilization. More than this, he believes that by the publication and distribution of frequent bulletins on technical, industrial and commercial subjects, by its faculty taking part in the meetings and conventions of the various technical, industrial and commercial interests and societies, and eventually perhaps by systematic extension lectures and correspondence courses, the technical school should seek to educate the industrial and commercial public in the applications of science to their work.

It is the special object of this paper, however, to make a plea for systematic, original investigation in technical schools. The necessity for work along this line has been so great and so plainly apparent that a great deal has already been accomplished. The term *original investigation* should be understood to include much besides experimental research. The writing of good technical books, for example, involves a large amount of original study and research, for such books should never be mere compilations. In the columns of one of our principal technical journals 73 technical books were reviewed during the year 1899, and 25 of these were written by professors in engineering schools. There is not a single technical journal, and perhaps not an important technical society publication in the country to whose columns frequent contributions are not made by engineering educators. The current of progress of technical education is sweeping engineering professors farther and farther away from the old exclusive devotion to class room instruction, and more and more bearing them into active participation in the daily outside work of their professions.

The development of original investigation at technical schools has been especially rapid in late years along the line of experimental research. The modern methods of instruction require extensive and expensive laboratory equipment, which is also available for experimental research. The multitude of subjects pressingly needing such research is so great that energetic engineering instructors are naturally led into experimental investigations. Frequent reports of the results of such work are seen in the technical society proceedings. Also most engineering schools maintain regular publications, in which the results of many experimental investigations by both faculty and undergraduates are reported. It is impossible to mention here many of the numerous important experimental investigations which have been made at American engineering schools, but attention will be called to two cases: first, all are familiar with the important work in connection with paving brick which has been done at the universities of Ohio and Illinois, and which has been accepted as authoritative by both engineers and manufacturers; second, the great hydraulic laboratory at Cornell has required the most lavish expenditure of money devoted exclusively to preparation for experimental research in a single line of work yet seen at an American technical school.

The great value of such investigations to the engineering profession is readily apparent. The value in connection with the instruction of engineering students is also great. Bringing the student into personal contact with the progress of such investigations, carried on by his instructors, does much to awaken in him professional enthusiasm and an ambition to become himself a contributor in the future to the common stock of technical knowledge. The student is led to see that there is much more in engineering education than the mere absorption of knowledge, and much more to engineering practice than the mere routine of carrying out pre-established methods. He sees that he must learn to think for himself in his future work, and to investigate for himself the problems which he will encounter. In the simpler work connected with experimental investigations bright, reliable students can often be employed to advantage. This is especially true in work suited to thesis investigations. The author knows of no more valuable training a student can have than to carry out successfully an experimental research, overcoming all the unforseen difficulties sure to be encountered, and at the end completely digesting the results obtained. The author believes, however, that all experimental work by undergraduates should be done under very close supervision by a skilled instructor. Much valuable thesis work has been done in this way at engineering schools.

While much has already been accomplished in orginal investigations at American technical schools, such work has heretofore, with few important exceptions, been carried on spasmodically, with no systematic pre-arranged plan. The author believes that this should now be changed, and that wherever possible technical schools should deliberately plan for investigations as a part of their regular work. Each school should decide what lines of work are best suited to its location and circumstances. Proper space and equipment should be provided. The faculty should be made large enough to permit the necessary time to be devoted to the work. Funds should be provided to meet the expenses. Arrangements should be made for the regular publication of the results.

Investigations which can be carried out at engineering schools are of two kinds: first, those mainly of professional interest and value; and second, investigations whose results have a considerable commercial, industrial and public, as well as professional value.

As to investigations of the first kind it may be said that the practicing engineer frequently encounters problems which ought to be investigated experimentally, but it is seldom the case that he can command the necessary laboratory equipment or the time for such work, or induce his employers to furnish the necessary funds. Such problems should be referred to the schools and there investigated. Thus the schools may perform their duty to the profession, and may ask in return, as they do even now, that the practicing expert shall give them the benefit of his experience, in non-resident lecture courses. There will result that co-operation and close association between the engineering educator and the practicing engineer which is so essential to the best interests of the profession.

As regards investigations having a commercial and industrial value, attention may be called to the prominence which has recently been given to discussion of the value of scientific technical training for the leaders and workers in our manufacturing and commercial industries. The mono-technic and the trade schools of Germany have been held up as models for the world. The author believes that, under American conditions, the first decisive step towards solving this problem should be taken at the technical schools, especially the state colleges and state universities which are the beneficiaries of the Morrill government aid laws. The nearest approach now made to systematic technical education for one industry in this country is seen at our agricultural schools and experiment stations. At the best of these schools not only are the students given a thorough scientific education and training for leaders in agricultural work, but also extensive scientific agricultural experiments and investigations are continually being carried on. The results are systematically published and distributed in bulletins. The faculties attend the regular meetings of the institutes and conventions of agricultural interests, and there inform the public concerning the results of the college work and the principles of scientific agriculture. The author believes that similar training and aid should be given by our technical schools to American manufacturing, commercial and other industrial interests. At least, investigations helpful to these interests should be undertaken, and the results systematically published. The school which will undertake such work will receive hearty support from the industrial interests of the country, and means for carrying on the work will not be lacking.

In a new and rapidly developing country like ours there are many yet untouched resources. It would greatly accelerate the development of these if scientific investigations of their possibilities were made by the technical schools. For example, in the case of quarries, deposits of cement materials and clay deposits, both the raw materials and the finished products can be carefully tested and their qualities published. Again, in processes of manufacture, the effect of different processes in the quality of the product can be studied. New applications of botany, chemistry and physics to manufacturing processes can be found.

In fact the subjects suitable for investigation at engineering schools are very numerous, and no attempt will be made here to give an exhaustive list. The following may be mentioned:

Theoretical Mechanics.—Experimental studies, accompanied by mathematical investigations of the theory, may be made of such problems as the actual pressure against retaining walls, the theory of concrete and steel combinations, problems in hydraulics, and many others.

Materials of Construction.—The methods for testing the materials of construction need extensive experimental investigation, and should be completely standardized. The properties of both long used and of new materials may be studied and made known. Standard specifications may be prepared for the properties developed by the standard tests.

Sewage Disposal and Water Supply.—The methods of analysis of sewage and water need careful experimental study to determine the best methods and the interpretation to be placed on the results. Analyses of sewage and water can be made for the municipalities and corporations of the state. Many sewage and water purification problems can be studied experimentally, and systematic examinations and reports can be made of existing plants in the State

Steam and Electrical Engineering.—Laboratories can be provided for tests of different kinds of machinery, and for the experimental investigation of problems of correct design. Efficiency tests of outside plants can be made.

Mining Engineering.—Geological studies of deposits of building stones, cement materials, clays, fuels and ores can be made, and the qualities tested.

Manufacturing.—Applications of science to manufacturing and the comparative values of different processes can be studied, as already mentioned. With the aid of statistics, political economy as related to manufacturing, can be studied.

Transportation.—Good roads and road materials in the State can be studied. Laboratories can be established, fitted for tests of transportation machinery. The political economy of transportation problems can be studied.

The author does not claim that any one school should undertake all of the above lines of work. On the contrary, the work undertaken by any one school should be restricted to what it can carry on for a long period of time, and so extensively and thoroughly that the results shall be conclusive. Particular schools would naturally become authorities in particular lines, and their work would not be duplicated by others, although many lines of work would need to be carried on by several schools, because local conditions differ.

As an illustration of a modest and imperfect beginning of such work, made under many difficulties, the author would say that at the school with which he is connected the following lines of work are now under way:

The college has a sewage disposal plant which purifies about 50,000 gallons per day. Regular analyses in connection with this plant are made, complete records are kept, and investigations with the plant are under way. Special tests with smaller apparatus are planned. The college has just co-operated with a neighboring city, securing and publishing at the expense of the city the preliminary data for the design of a purification plant for 2,000,000 gallons of sewage per day. The college proposes to examine and report upon sewage disposal plants as fast as they are installed in the State. In connection with the clay interests of the State quite a large number of plants have been visited, samples of clay and brick secured for tests, the clays and processes of manufacture studied, and several thousand tests are under way. Samples of new clay deposits are frequently received, analyzed and reported upon. An appropriation has been made for starting a ceramic laboratory, modelled after the one at the Ohio State University. A set of tests of the heating properties of the coals of the State is under way. Tests of the building and paving materials of the State are being made, and extensive statistics of brick paving collected. Special investigations of timely interest are taken up as opportunity permits. It is proposed to extend this work.

It is obvious that if the extension of the work of the modern technical school advocated in this paper could be made to the utmost possible extent, the status of the technical school would be greatly changed from what it now is. No longer could the schools be considered as existing simply for the benefit of its students. All practicing engineers would equally consider it theirs, and the great industrial and commercial interests of the country would consider it theirs. Such a technical school would be one of the most potent agencies imaginable for the betterment of the welfare of the people, and for the progress of modern civilization.

A. Marston.

Iowa State College.

*THE DEVELOPMENT OF THE CONGER EEL.**

On July 31st, Dr. Porter E. Sargent, while on the U. S. Fish Commission vessel *Grampus* on the tile-fish banks (about 40 miles south of South Shoal), secured a number of species of pelagic fish eggs. One of these is very probably that of the Conger eel.

I have followed the development of this egg, and the larvæ hatched from it during two weeks. In view of the fact that no ripe eel eggs had been seen except in a limited region of the Mediterranean, a brief résumé of the results of my work on these eggs may be of interest. But first a note on the modern phase of the eel question will not be out of place.

In 1888, Raffaele figured and described a number of species of pelagic eggs which, on account of the shape of the larvæ they produced, he referred to various species of eels without a further attempt to refer them to definite species.

In 1897, Grassi published his series of epoch-making works on the eel question. He also found the eggs described by Raffaele, but of more importance was his identification of various species of Leptocephali as the normal larval stages of various eels. His conclusions in brief were: 1st, that the eggs of eels mature at great depths, 500 meters; 2d, that the eggs, except occasionally, develop at great depths; 3d, that the eggs give rise to a præ-larva, that this gives rise to a larva (the Leptocephalus), that this in turn gives rise to a hemilarva which finally is metamorphosed into the definitive adult which may be much shorter than the Leptocephalus from which it arose; 4th, that the egg of the common eel is without an oil globule.

The eggs secured during this summer are very nearly, if not quite like one of those described by Raffaele. They have all the characters of a pelagic egg, and Grassi was probably mistaken when he stated that these eggs come to the surface only occasionally. They are large, measuring from 2.4 to 2.75 mm. from membrane to membrane. The yolk is in segments, and measures 1.75 to 2 mm. in diameter, thus leaving a large perivitelline space. There are usually several oil globules, one of which is very much larger than the others. Some of these eggs hatched on the fourth day, others not until several days later. There are several distinct and unique features in the development, most of which have been well described and figured by Raffaele. (I have not seen Grassi's illustrated work.)

First among the peculiar features is the shape of the yolk. This in later stages of development becomes a long, slender mass reaching from the heart along the base of the alimentary canal to near the anus. This mass becomes constricted in places and the last seen of the yolk is a series of small disconnected bead-like masses distributed at intervals along the base of the alimentary canal. The yolk mass in the yolk sack diminishes very rapidly, partly by absorption, and partly, no doubt, by becoming located in the sub-alimentary yolk mass. A constriction is formed between it and the posterior yolk to which it forms a sort of handle. The oil spheres remain in the handle of the yolk mass. This elongation of the yolk is a definite adaptation to the elongate body and eeling progression of the larva.

The number of abdominal protovertebræ is exceptionally large, numbering between 65 and 71 in the present case.

The medulla becomes early and remains late a large, conspicuous, thin-roofed vesicle.

The color appears late. Only black pigments appear. In the last stages reached it

* By permission of Dr. H. C. Bumpus, director of the Woods Holl Laboratory of the U. S. Fish Commission. The details will be published by the Fish Commission.

consists of a series of ten spots along the region of the alimentary canal and lower part of the tail, a black spot about the end of the tail and another at the tip of the lower jaw, with a few cells on the upper jaw.

Especially noteworthy is the development of enormous fang-like teeth, four pairs in each jaw. The upper decrease in length from the front backwards, while those of the lower jaw are nearly of uniform size.

When first hatched the larvæ floated vertically, near the surface, heads up, tails down. Later they assumed the horizontal position and explored all parts of the vessel in which they were contained, progressing in approved eel fashion and biting at nearly everything touched.

The evidence that the eggs are those of the Conger is not positive. If Grassi is right, these eggs cannot belong to the common eel. The Conger eel is the only other one abundant in the region in which the eggs were collected and was caught in numbers at the time the eggs were collected. The serious objection to referring them to the Conger is the large number of segments in front of the anus. Since, however, according to Grassi, the anus migrates to near the end of the tail during the changes to the Leptocephalus stage, the number of segments in front of the anus is probably not positively available in the identification of the larva.

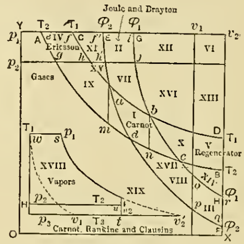
Carl H. Eigenmann.

Woods Holl, Mass., August 25, 1900.

HEAT-ENGINE DIAGRAMS.

The accompanying diagram, in which are shown the possible compositions of the four standard thermodynamic lines in the formation of heat-engine diagrams or thermodynamic cycles, has been found so useful during twenty years' experience in its employment that it has seemed possible that it may prove deserving of extended publication. It has just been engraved in this particular form for illustration of a new edition of the 'Manual of the Steam-engine.' Gas-engine cycles are seen to number no less than seventeen, of which a large proportion are mechanically and kinematically practical, and a half-dozen of which have been adopted or designed by engineers.

The Carnot, or Sterling—*I*, *a b c d*—and its equivalent, *a b n m*, or *V*, the regenerator cycle, only, it is recognized, can yield maximum efficiency, as a thermodynamic



proposition; but the Joule, or Brayton, and the Ericsson, among the gas-engine cycles and the Rankins and Clausius among vapor-engine cycles have been found available by designers and builders, and it is probable that, among the infinite number of conceivable cycles outside the class here illustrated, many may be found capable of meeting the demand of the engineer for a practical union of thermodynamic, mechanical and kinematic closed cycles.

The production of the cycle of Carnot is not a difficult task as a matter of design but, in the case of the gas-engine, it involves too extensive a variation of volume to find place in application. It is far more practicable with vapor-engines and Cotterill long since suggested a practical approximation of which the engineers of our own day are beginning to avail themselves.

R. H. Thurston.

HERMAN ANDREAS LOOS.

THE death of Dr. Herman Andreas Loos which has already been noticed in these columns, adds another to the long list of men of science whose lives have been blotted out by the scourges of the tropics.

Dr. Loos, though a very young man, was a chemist of exceptional promise. He was granted the degree of Bachelor of Science by the College of the City of New York in 1895. In 1897 he entered the School of Chemistry of Columbia University. When temporary business reverses removed the available funds for the completion of his education, he put his shoulder to the wheel and for two years before he entered Columbia taught in both the day and the night schools of this city. While doing his graduate work in the University he ably filled the instructorship in Chemistry in the East Side Evening High School. As an honor for his ability and perseverance he was awarded the University Fellowship in Chemistry for 1899–1900.

His principal contributions to the literature of chemistry are: 'The Electrolytic Determination of Zinc in Amalgam' (thesis for M. A.); 'A Study on the Metallic Carbonyls and their Decomposition (*School of Mines Quarterly 21*, 182); 'The Decomposition of Nickel Carbonyl in Solution' (*Journal American Chemical Society 22*, 144); 'A Study on Colophony Resin' (thesis for Ph.D.). In the study on Colophony Resin he has decided two controverted points, viz: that abietic acid will form an anhydride on heating, and that it is not an oxidation product of turpentine. He has also developed a new method for the preparation of pure abietic acid and established its formula by a number of analyses. Many new salts were prepared and their decomposition both by water and sunlight, noted. The whole work is of great theoretical and practical interest.

Immediately after receiving his degree Dr. Loos was appointed assistant in analytical chemistry in Columbia University. He resigned this position, however, to accept a flattering offer from the Copper Corporation of Chili, and it was while en route to Chañaral that he was stricken with yellow fever, of which he died July 17th.

At the age of twenty-four, by his own efforts, he had earned an education and established for his name an honorable place in the literature of his profession. No finer tribute can be paid to his energy and ability and ambition. Strange indeed must be one's thoughts when it is realized that the victims of yellow fever on board the steamship *Chili* were Italians or Chinese laborers with the one exception, the brilliant, energetic, educated Dr. Loos.

MILTON C. WHITAKER.
COLUMBIA UNIVERSITY,
September 1, 1900.

SCIENTIFIC BOOKS.

Photometrical Measurements and Manual for the general Practice of Photometry with especial Reference to the Photometry of Arc and Incandescent Lamps. By WILBUR M. STINE, Ph.D. New York, The Macmillan Company.

The scope of this little manual is indicated in its subtitle. The arrangement and proportioning of the material look always toward electric light photometry. Subjects which have a scientific, rather than an industrial interest, like spectrophotometry, are briefly dealt with, or omitted altogether, and the gas-engineer will find no reference to the special problems with which he has to struggle. Within the limits set by himself, Dr. Stine has produced a useful book. Less compact than Krüss, less comprehensive than Palaz, it is perhaps more directly adapted to the student than either. The material is judiciously selected, the discussions are clear and careful, the bibliographical references amply sufficient for the purposes of the book.

Some two-thirds of the volume are occupied in discussion and criticism of photometric instruments and standards of light, thirty or forty pages are given to general and theoretical considerations, and the remainder is devoted to practical suggestions and directions.

In the discussions of photometric apparatus, such types have been selected as have been shown by experience to be really useful. Among these, the Bunsen screen holds easily the first place, from actual use, convenience, and sensitiveness, though attention might well have been called to its two notable weaknesses:

1. That it violates a fundamental principle of photometric construction, namely, that the portions of the photometric screen which are used for comparison should be illuminated each by one only of the lights to be compared, and not by both. The violation of this principle renders it possible, as is shown in the analytic discussion, to make settings in any one of three ways, which may give quite different readings, so that agreement is only obtained (and not surely even so) by reversing the instrument. How many users of the Bunsen screen for industrial purposes habitually reverse their photometers?

2. That the ordinary binocular use of this instrument is attended by the possibility of a considerable constant error. This is indeed pointed out on page 210, but is of sufficient importance to deserve mention in the description of the photometer itself.

It is questionable also whether the old shadow photometer is not too hardly dealt with. The illustration on page 54, though similar to that generally given in books on the subject, affords no idea of the proper use of the instrument. When arranged in the most advantageous manner this photometer becomes convenient in use to an extent hardly approached by any other form, and sufficiently sensitive for most work.

The bolometer, as a photometer, is dismissed with a few lines, yet it is worth noting that while energy measurers—like the bolometer—which can be made to register their results mechanically, do not measure the physiological sensation of light, yet for certain purposes they may be most useful. The variation in brightness of a light, within not too large limits, takes place generally without changing materially the character of the light, and hence is proportional to the corresponding change in energy. Such questions as the steadiness of a standard can be investigated by means of a bolometer with far more precision than by any photometric arrangement. No photometric indictment against the standard candle has ever approached in severity the curves obtained by Nichols and Sharp, in the work referred to by the author.

The method is recommended in the chapter on arc light photometry, of calibrating an incandescent lamp at white heat, by comparing in succession lights of higher and higher incandescence, starting with the ordinary yellowish standard, until through a series of steps the required limit is reached. This is a questionable method in practice. As the change of color in the successive steps is always in the same direction, from yellow toward white, errors made on account of the differing colors of the lights are likely to be always in the same direction, and therefore cumulative. I have found it very difficult to make a series of measurements of this kind tally in their final results with a direct comparison between the limits of the series made with a flicker photometer.

But these are small questions and affect but little the value of a book which may be recommended to students of the subject as a safe and efficient guide.

Frank P. Whitman.

LIVERPOOL MARINE BIOLOGICAL COMMITTEE'S MEMOIRS.

Numbers II. and III. of the Liverpool Marine Biological Committee's memoirs have recently come to hand. It was hardly to be expected that the standard of scientific excellence set by No. I. of the series, on *Ascidia* (see Science, January 19, 1900), written by the most experienced ascidiologist living, could be reached by all succeeding numbers. If, however, the two now under review may be accepted as establishing the quality of those that are to be prepared by specialists less distinguished than is Professor Herdman, the writer of the first number and editor of the series, a set of very valuable little books is to be the outcome of this unique undertaking.

Their usefulness will be by no means restricted to English laboratories of elementary instruction, but will extend to the reference libraries of many professional zoologists.

Number II., by Mr. J. Johnstone, is on *Cardium;* and number III., by H. C. Chadwick, is on *Echinus*. The former contains 84 pp. and 7 pls.; the latter 28 pp. and 5 pls.

In *Cardium* the sections, 'General Organization, Mantle and Foot,' 'Shell,' 'Alimentary Canal,' 'Branchia,' 'Vascular System,' and 'Course of the Circulation,' are particularly well done. One rarely finds in works on the lamellibranchs of the general scope and purpose of this the crystalline style and the method of extending the siphons and foot better treated than here. The renal, nervous and reproductive systems do not fare quite so well, relatively. The histology of the nervous system, for example, is not touched upon at all, while it is entered into with some detail for all the other systems.

The treatment of the renal system is somewhat deficient in illustration, and consequently lacks to some extent in clearness. And here one wonders why the terms 'organ of Bojanus' and nephridia, so well established in lamellibranch morphology, are not even mentioned.

The absence of any reference to the cœlon, at least under that name, is strange.

A feature of this particular monograph, and one which will undoubtedly both extend and enhance its local value, is an appendix on 'The Economy of the Cockle, with special reference to the Lancashire Sea-Fisheries District.'

The *Echinus*, though perhaps not reaching at any point quite so high a level of descriptive excellence as does *Cardium* in a few sections, is more even. It is good throughout.

Both monographs contain much evidence that their authors have not only a large fund of first-hand knowledge of their subjects, but have also wide acquaintance with the original literature bearing upon them.

One constantly wishes that zoological treatises of this general type might contain more physiology and natural history with the morphology than they do; but here the desiderata are usually beyond the power of the authors to remedy. The three numbers of this series thus far put out are certainly less defective in this way than are many general works.

None of the numbers thus far issued have either tables of contents or indexes, and they should certainly have both; their value would be greatly enhanced thereby.

I would again express regret that the volumes cannot be more securely bound. A number of forms in the copy of *Cardium* that has come into my hands are now nearly ready to fall out, and the book has had no hard usage. The educational worth of the books certainly ought to insure them a place in many laboratories and reference libraries; and their usefulness ought not to be impaired by defective construction.

Wm. E. Ritter.

SCIENTIFIC JOURNALS AND ARTICLES.

Popular Astronomy for August and September, published at Northfield, Minn., contains, as leading articles, views of some prominent astronomers, about the present opposition of the planet Eros as favorable for a study of this new planet's parallax. If its parallax can be obtained, micrometrically and photographically as accurately as is now believed, the result will help to a better knowledge of the solar parallax. Such knowledge would improve most of the constants of the solar system. S. J. Brown, Astronomical Director of the United States Naval Observatory, has prepared the first and second articles. The first is on the feasibility of obtaining the solar parallax from simultaneous micrometric observations of Eros, and the second is a translation from the French of two circulars issued by the International Astrophotographic Conference at its meetings in July and August last, giving instructions to all the astronomers of the world who are expected to co-operate in observing Eros during September and October. Director Brown gives useful comments on these circulars. Other articles are: 'Ptolemy's Theorem on the apparent Enlargement of the Sun and Moon near the Horizon,' by Dr. T. J. J. See, Washington, D. C.; 'Total Eclipse of May 28, 1900,' by Professor M. Moyé, University at Montpellier, France; an illustrated article on the same subject by the editor; 'The Propagation of the Tidal Wave,' by Dr. T. J. J. See; 'The Planet Jupiter,' by G. W. Hough, and an obituary notice of 'Piazzi Smyth,' by Ralph Copeland. Notes as usual are published on variable stars, planets and current spectroscopic work.

DISCUSSION AND CORRESPONDENCE.

NOTE ON THE SILURO–DEVONIC BOUNDARY.

In the recently published bulletin of the U. S. Geological Survey, No. 165, entitled 'Contributions to the Geology of Maine,' Professor H. S. Williams has again defined his attitude on the question of the Siluro-Devonic boundary in America. Here the critical argument advanced with some emphasis for the construction of the Helderbergian as a Siluric fauna is given in the following words (p. 25):

"The boundary between the Silurian and Devonian systems was first made in the Welsh series, in which the transition was from calcareous sedimentation, with rich and purely marine faunas, into sandstones of great thickness containing land plants and fishes whose habitat was, presumably, fresh or brackish waters.

"The New York section, from the Lower Helderberg limestones through the Oriskany, Cauda-galli, and Schoharie grits back again into limestones, does not pass out of marine conditions. In the Gaspé region, however, there is a complete change (as there was on the other side of the Atlantic Basin) at the point where the Oriskany fauna was evolved. [Note A.] In these Silurian faunas of the eastern province there is also much closer resemblance to the Wenlock-Ludlow series than is found in the faunas of the Appalachian province in New York. The correlation of the passage beds at the top of the Silurian of Wales is clearly to be recognized in the passage from the limestones to the Gaspé sandstones of the eastern province of America. This Gaspé transition is also to be traced with precision to the horizon of the introduction of the Oriskany fauna into the basins farther west and southwest, in which no direct passage into Old Red sandstone condition is apparent.

"We have thus in America a means of determining where the Silurian boundary belongs in purely marine series of beds and among marine faunas of unbroken succession. The Lower Helderberg in the interior of the American continent, as the Koniprusien F_2 fauna in the Bohemian Basin of Europe, is closely related in its species to what succeeds, because there was no radical disturbance of the conditions of marine life. Nevertheless, it is not the Lower Helderberg species that mark the conditions corresponding to the beginning of the Old Red sandstone; but the changes which that fauna suffered during the passage into the Oriskany time are evidences of a general disturbance which resulted in the lifting of large areas of marine surface above the level of the sea." [Note B.]

Note A.—This statement is wholly inaccurate. In the Gaspé limestones the Oriskany fauna manifests itself pronouncedly with *Hipparionyx proximus*, *Rensselæria ovoides*, *Megalanteris*, *Camarotœchia pliopleura*, *Rhipdomella*, cf. *musculosa*, *Meristella* cf. *lata*, etc., at the base of Logan's limestone No. 8, and above this horizon is the great thickness of 500–600 feet of pure limestone beds with chert bands, surprisingly similar in lithologic aspect to the gray and chocolate-colored Onondaga limestones of New York, and throughout these beds such Oriskany species are found in association with a profusion of others not represented in the interior basin Oriskany and many of them closely comparable to species of the Helderbergian. The plane of reappearance of certain Oriskany species in the Gaspé sandstone above, was shown by Logan to be 1100 feet above the top of these limestones and to be restricted to a comparatively slight vertical range. The fossils of the sandstone are not abundant nor is the fauna diversified. To any one studying these relations on the ground it is clear that they represent a brief return of the fauna of the limestone with evidences of progression and the further intermixture of species from the interior province (*Rensselæria* cf. *ovoides*, *Chonostrophia dawsoni* and *Chonetes melonica* (both of the latter in the New York Oriskany), *Leptostrophia blainvilli*, cf. Oriskany species, *Orthothetes becraftensis*, *Phacops* probably identical with *P. anceps*). The evidence from the Gaspé series is potent and conclusive that the introduction of the Oriskany fauna was accompanied by the deposition of pure calcareous sediments which were continued for a protracted period and nearly equal in actual thickness, the sum total of the Helderbergian and Onondaga limestones in the New York area of the interior basin. The species cited are in themselves evidence of the wide transgression during Oriskany time which is especially noticeable in the distribution of the sediment in New York. No tectonic change disturbs the succession in the 2000 feet of Gaspé limestones.

The fauna alone shows that during the earlier part of the period of their deposition the eastern province was more completely secluded from the interior sea than during its later stages. The Canadian geologists have expressed the probability that the 7000 feet of arenaceous sediments comprising the Gaspé sandstone may represent the major part of all subsequent Devonic deposition in that region.

Note B.—The fauna of the Helderbergian passes upward into the deposits of the Oriskany without abrupt or profound change. Its species perdure, but progress and definition are evinced in the later fauna by the introduction of many distinct types.

The prevailing conception of the Oriskany as a purely arenaceous deposit and which figures largely throughout this argument is one which needs readjustment. The normal fauna of the Oriskany of New York is that of the calcareous beds of the eastern part of the basin. These beds always contain a considerable content of silica in the form of sand, but they are clearly the deeper water deposits of which the sandstone beds of the typical Oriskany section and the intermediate thin bands of altered sandstone (quartzite) are the shallow water shore-line deposits. The sandy layers of the Oriskany only share the fauna of the calcareous beds, and it is quite clear that their species have been derived from the deeper water centers of dispersion largely through mechanical agency. It is therefore not competent to argue a lower calcareous Oriskany and an upper arenaceous Oriskany, as, in New York, at least, there is but one Oriskany fauna, and the formation is not divisible into facies except geographically.

The foregoing notes indicate that the argument cited is built upon the sand. Nevertheless it is throughout that which served de Verneuil and Murchison above fifty years ago and through that agency produced its effect upon Hall's correlation of the Oriskany and Lower Helderberg. It is that argument too with no additions, summed up in the statement that Siluric time was closed with a general worldwide crustal elevation initiating rapid baseleveling and the accumulation of sandy deposits at the opening of the Devonic in all countries. To the recrudescence of this ancient doctrine the labors of Kayser, Frech, Tschernyschew and other European geologists upon the calcareous facies of the earliest Devonian in the Harz, Westphalia, Bohemia and the Urals afford no balm. The old hypothesis of cycles of sedimentation loses force when applied simultaneously to every part of the earth's surface, and cycles of sedimentation are not a basis of geologic classification save as some element therein indicates widespread orographic derangement. The argument as here constructed seems to be as follows: The grand event which terminated the Siluric was the universal elevation of the land, the erosion of which supplied the materials for the sandy sediments of the opening stages of the Devonic. This opening Devonic stage in the marine succession is impregnated with species of Oriskany type; 'the Lower Helderberg is therefore proven to belong to the typical Silurian system of the American Continent' (*op. cit.*, p. 26). Both premises limp and the conclusion falls. The deposition of sandy sediment was not contemporaneous in the early Devonic, but, however widespread, it may have been upon the epicontinental plateau, calcareous sediments of contemporary origin must have been present in the greater and less disturbed depths, retaining some of the preexisting types, but showing freely the progressed and differentiated types of the new era. These relations of coeval faunas can be determined only upon the most careful analysis of organic content, and such analysis has cogently shown the intimate affinity of the Helderbergian with the calcareous Oriskany of which it is the immediate and purest calcareous predecessor in the vertical series. As in the Gaspé succession, so in New York, the species of Helderbergian time, notably unlike in the two separated provinces, pass, in each, into association with those of the Oriskany when by transgressing sedimentation and freer intercourse between the provinces a consequent commonalty of species was effected.

The succession in the Gaspé peninsula like that of the basins of Bohemia and the Urals again declares the ultimate and final authority of the fauna, its variations, progression and specialization, in pronouncing upon a critical question in the classification of the fossiliferous rocks.

JOHN M. CLARKE.

THE PROBLEM OF COLOR.

ALTHOUGH I don't accept Professor Cattell's contention, in the last number of the *Psychological Review*, that the nugatory process by which two colored lights (if properly chosen in hue and in intensity) disappear for sensation and leave behind a sense of grayness only is due to a cortical and not to a retinal physiological process, I am nevertheless willing (in the interest of fair play) to furnish him with one more reason on his side. When a colored object is mirrored in a piece of colored glass (say red in blue), we get in general a color blend, that is, for consciousness, a reddish-blue sensation. In case the colors chosen are a pair which, on fusing, are transformed into something else (yellow and blue into white, or red and green into yellow), this is, according to all the non-psychical color-theories, because two counteracting color-processes in the retina are exactly balanced, or else because two partial photo-chemical molecular dissociations unite to complete each other and to produce an undifferentiated gray-process,—either of these suppositions being sufficiently plausible in itself. But—and this is the fact, if it is a fact, which works upon Professor Cattell's side—there are occasions upon which, according to Helmholtz and to Wundt, this antagonism, or this completion, fails to take place. One sometimes sees, they say, one color *through* the other; guided by the belief that the red sensation is due to the presence of a red book, *e. g.*, one cannot help but *see* the redness of the book through the sea of blue. They do not dwell upon the colors which they used in making the experiment—so long as these are red and blue there is nothing strange in the differing interpretations; but if, under these circumstances, blue and yellow should not give white (and red and green should not give yellow), then it would seem to follow that the antagonistic or the completing processes are not of the nature of chemical changes in the retina—such could not be so easily undone by the reasoning, or the perceiving, Psyche. Hering denies with great warmth the contention of Helmholtz and of Wundt that these exceptional cases occur; or rather, he says that if they do occur it is owing to spots or unevennesses in one or the other of the two surfaces. But even though she be assisted by any ulterior aids whatever, it would not seem that the Psyche can undo, in the interests of reasonable interpretation, a chemical change that has already taken place. Perhaps she can, however; but in that case her powers must also suffice to undo an *actual* white (or yellow) and separate it into its possible components. If, in the case of a blue book seen in a yellow glass, for a portion in the center of the surface of the book a gray of equal brightness be substituted, and a like gray for an exactly coinciding portion of the yellow reflector, then it is possible that self-deception would go so far as to enable us to see a continuous blue book in a continuous yellow mirror. The experiment is perhaps worth trying.

On the other hand (to be equally fair to my own side, in turn), the fact that *binocular* color mixture does not occur to any great extent—that is, does not occur for colors far apart in the spectrum—is at once destructive to any hypothesis which relegates the fusion of colors to the perception-forming centers of the brain. Whether an overlapping blue and yellow are mediated by one eye or by two can have nothing to do with the case if their mutual quenching is an affair of perception. Helmholtz, after a long series of the most painstaking experiments, declared absolutely that binocular color-fusion does not take place.* This shows, in passing, the unprejudiced character of his work, for the fact, as I have said, is quite destructive to his theory that the mutual suppression of blue and yellow into white is merely a matter of the judgment: it cannot make any difference whether we know that we see blue and yellow at once through one nasal half-retina, or through a nasal and a temporal half-retina together—the more so as we have in general

* Binocular color-fusing of two complementary colors many be obtained with the Hering color-mixer by 'long and steady gazing,' but this is the sufficient condition for turning each color into a dead gray, when looked at by itself.

absolutely no consciousness as to which eye we are seeing anything with.

It is customary to speak of color-mixing as if it were the same sort of thing throughout the whole spectrum, but in reality it is of two very different kinds. When a unitary green and blue are mixed to produce a blue-green, the phenomenon is purely a psychological one (and there is nothing strange in the fact that such mixtures work binocularly as well as monocularly); we can see in the blue-green the blue and the green of which it is composed (and we have not even in this case taken the trouble to devise a separate name for it). But if a spectral red and a spectral green in neither of which any trace of yellow can be detected be seen together (and even if one of them is a trifle bluish), a yellow is produced which has not any perceptible falling off, even in saturation, from the yellow of the spectrum (as has just been stated explicitly by Breuer and von Kries); and a correspondingly strange event results from the mixing of blue and yellow. To say that such a transformation-scene as this is the work of judgment (the judgment being led to it by no motive whatever—it cannot be anything in reality, it would seem, but the pure spontaneous play of fancy, rather than the work of a reasons-obeying judgment, or perception)—this is to make a serious draft upon the powers with which we need to endue that faculty, or, to use the more modern term, that cortical center. At all events, the two occurrences are very different, and my object now is merely to suggest that they should be called by different names. When green and yellow producing ether-radiations are thrown together upon the retina, I would propose that the yellow-green sensation which results, be called a *color-blend*, and that the two colors be said to be blended. But when yellow and blue unite to make gray, I should say, using in fact a term of Helmholtz's, that the process is one of mutual *color-quenching* (and in the same way red and green may be said to quench each other when they result in yellow). Color-blending is plainly a psychological matter; color-quenching it is far more natural, in the first instance, to attribute to a peculiarity of the photo-chemical processes which we know to be going on in the retina.

Farther—still in the interest of mutual comprehensibility between the adherents of different schools, who speak at present languages which have too little in common—I would propose to call red, yellow, blue, and green, not primary, nor elementary, nor fundamental colors—that commits one to one or other of the rival schools; not 'principal' colors—that is purely an æsthetic designation; but *unitary* colors. Since the admirable discussion of this subject by Professor Elias Müller (*Ztsch. f. Psychol.*, Vols. X. and XIV.) no one can doubt—even of those who doubted it before—that these particular ether-radiations have for consciousness a peculiar character—that of being the end-members of 'rectilinear' color-series (series such that each member differs from the one before it *in the same way* in which that differs from the one next preceding); in other words, they are not, for consciousness, of the nature of *color-blends*. Yellow-green and green-blue are —on their faces—color-blends. Orange and violet have secured unitary names for themselves (though they are nothing but a reddish yellow and a reddish blue)—doubtless on account of the excessive interest which attaches to reds in nature as compared with greens; but that is not sufficient to make them unitary colors. This nomenclature commits one to no theory whatever—whether retinal or cortical; it is simply the expression of the psychological fact that there are four very characteristic points in the color gamut, red, yellow, green and blue, their character being sufficiently described by the word *unitary*. That this is true will easily be seen by any one who will take the trouble to spread out for himself in order in a circle as many different color-hues (all of the same saturation and the same brightness—the spectrum will not do, therefore), as can be procured.

To conclude, a color-blend is then surely a psychological product; an instance of color-quenching is either psychical or physiological according to the theory which one is pleased to adopt. How hard it is for the physicists to understand this point of view is evidenced by the fact that they are constantly affirming that fresh proof has been adduced of the Young-Helmholtz theory, because it has been shown that all the colors of the rainbow and white besides can be made out of the *physical* mixture of red and green and blue. That fact has been put beyond doubt, once for all, by the exceedingly exact measurements of Professor König, made by means of an instrument of very ingenious construction (and so expensive that it has been duplicated for hardly any other laboratories). There is not a psychologist who denies this physical fact, and for the physicist to constantly re-affirm it, and to say that it has received fresh proof (see the report of the last meeting of the scientific societies in New York) is much the same as if he should valiantly affirm that one side of a shield is of silver by way of opposition to those who say that the other side is of gold. What the psychologist denies is not that gray results when blue and yellow are mixed upon the color wheel—he has admitted that long ago, and it will be found as an elementary statement in every text-book of psychology. But he refuses to admit, nevertheless, that white is an even red-green-blue *sensation* in the same sense in which purple is an even red-blue sensation. It is here that the adherents of the Young–Helmholtz theory should attack him.

C. Ladd Franklin.

A LARGE CRYSTAL OF SPODUMENE.

To the Editor of Science: There has recently appeared in some scientific journals a notice of a crystal of spodumene stated to be about twenty-nine feet long, and to be the largest known. It may be of interest to your readers to learn that a much larger crystal has been observed. In the year 1885 while studying the tin ore or cassiterite localities of the Black Hills of Dakota I saw and measured, in the Etta tin mine near Harney's Peak, a spodumene crystal thirty-eight feet and six inches in length and thirty-two inches in thickness. This thirty-eight and a half foot crystal was almost perfect, and was situated within a few yards of the surface. Owing to its size and the difficulties of transportation at that time, the railway being one hundred and thirty miles distant, I made no attempt to have the crystal removed. I, however, collected other crystals of spodumene in the vicinity, and some of these measured from two to six feet in length. Subsequently, in a public lecture upon the Black Hills, given in the University of North Dakota in February, 1886, I announced the discovery of the aforesaid gigantic crystal; but, because of the pressure of teaching and other numerous duties, that discovery has not been reported in the regular scientific journals.

For the benefit of some readers it may perhaps be well to state that spodumene is a grayish-white or pink mineral of considerable hardness, being nearly as hard as quartz, and that it consists of silica, alumina and lithium.

Henry Montgomery.

Trinity University, Toronto,
July 17, 1900.

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*UNITS AT THE INTERNATIONAL ELECTRICAL CONGRESS.**

At the suggestion of Professor Hospitalier, Section I. of the Congress agreed that the following should be the members of the Commission on Units: Messrs. Ayrton (Great Britain), De Chatelain (Russia), Dorn (Germany), De Fodor (Hungary), Eric Gérard (Belgium), Hospitalier (France), Lombardi (Italy), Kennelly (United States); and at the first meeting of the Commission, on August 21st, which was attended also by Professor F. Kohlrausch and Sir W. Preece—whose names had been added to the list of the government delegates for Germany and England—a report presented to the Congress by the American Institute of Electrical Engineers was taken into consideration. This report had been drawn up for that Institute by a committee appointed for this purpose, and it contained the following resolutions:

(1) We consider that it is necessary to give names to the absolute units in the electromagnetic and electrostatic systems, as well as convenient prefixes to designate the decimal multiples and submultiples of these units in addition to those already in use.

(2) The International Congress of Electricians, which will take place this year in Paris, should be invited to choose the names and the prefixes.

(3) A great advantage would be gained by a rationalization of the electric and magnetic

*From *Nature*.

units, and the Congress should be invited to find ways and means to obtain such a rationalization.

The proposition to rationalize the units—that is, to change them so that the coefficient 4π should not appear—was withdrawn by Dr. Kennelly on behalf of the United States; as well as the suggestion regarding the employment of prefixes, and it was resolved that:

The Commission will only deal with propositions that will introduce no change in the decisions arrived at at previous congresses.

A long discussion then took place as to whether it was really necessary to give names to the C. G. S. units either in the electrostatic or the electromagnetic systems, and finally it was agreed to withdraw the proposition so far as it dealt with the electrostatic system.

The desirability of giving a name to the unit of magnetic field and to the unit magnetic flux was strongly urged, and as the names of *Gauss* and *Weber* had been employed for some years in America for these units respectively, the advantage of adopting these names for the C. G. S. units of field and flux was advocated. On the other hand, the resolution arrived at by the Electrical Standards Committee of the British Association in 1895 to employ those names respectively for other units was pointed out. Finally, the Commission, at the end of their second sitting, on August 22d, recommended the following:—

"The Commission is not of opinion that it is necessary to give names to all the electromagnetic units.

"However, in view of the use already of practical instruments which give the strength of a magnetic field directly to C. G. S. units, the Commission recommends that the name of *Gauss* be assigned to this unit in the C. G. S. system.

"The Commission proposes to assign to the unit of magnetic flux, of which the magnitude will be subsequently defined, the name of *Maxwell*."

These resolutions were brought before Section I. of the Congress on August 24th, and led to a long discussion. M. Mascart opposed the giving a name to the C. G. S. unit of magnetic field. The employment of practical instruments for the direct measurement of the strength of magnetic fields in C. G. S. units was not, in his opinion, a sufficient reason for assigning a name to that unit. Besides, this decision of the Commission appeared to be contrary to the spirit of the Congresses of 1881 and 1889, which did not give the names of men to the C. G. S. units. He admitted that the name of a man might be given to the practical unit. In any case the name of 'Gauss' seemed to him liable to give rise to confusion, for Gauss was the originator of the first absolute system employed, viz, that of the 'millimetre-milligramme-second' system, and that system, as distinguished from the 'centimetre-gramme-second' system, was still in actual use in certain cases—for the measurement of the earth's field, for example.

Professor Kohlrausch said that the 'absolute units' were enough for the physicists, but that, if the engineers felt the need of practical units, Dr. Dorn and he did not see that any inconvenience would arise from names being given to them, such as those of Gauss and of Maxwell, for example. The German delegates could not, however, commit their Government in the matter, and they considered that the Congress should limit its recommendations to the use of these new names without seeking that legal sanction should be given to them.

Professor Ayrton agreed with M. Mascart, and mentioned that during the past five years many 'Ayrton-Mather Field Testers' had been constructed to read off the strength of a magnetic field directly in C. G. S. units, but that no need for any special name for that unit had been felt in connection therewith. He added, however, that, while holding the opinion expressed by M. Mascart that it was not desirable to give the names of persons to the C. G. S. units, the units of field and flux had this peculiarity, that without any multipliers they were the practical units adopted.

To this M. Mascart replied that the word 'practical' in this connection was ambiguous, since, although it was true that the C. G. S. units of magnetic field and flux were employed in practice, they did not belong to the so-called 'practical system.'

M. Hospitalier appealed to the Section to give names to the unit of field and the unit of flux. He did not ask for any legal decision in the matter, for the names were put forward as a simple recommendation to the Section.

After a discussion in which Messrs. Ayrton, Carpentier, Dorn, Hospitalier, Kohlrausch, Mailloux, Mascart, A. Siemens, Silvanus, Thompson and others took part, Professor Eric Gérard stated that in his opinion it was desirable to come first to a decision that names should be given to the C. G. S. units of magnetic field and to flux of magnetic induction.

M. Mascart, expressing his approbation of this idea, the president of the Section, M. Violle, put the following proposition formally to the meeting:

"The Section reeommends the adoption of specific names for the C. G. S. units of magnetic field and of magnetic flux." This proposition being adopted, with only two dissentients, the meeting was adjourned for a short time to enable the members to exchange their views regarding the exact names that should be employed. On the meeting reassembling, the president put the two following propositions successively:

(1) *The Section recommends the adoption of the name of* GAUSS *for the C. G. S. unit of magnetic field.*

(2) *The Section recommends the adoption of the name of* MAXWELL *for the C. G. S. unit of magnetic flux,*

both of which were adopted with only two dissentients.

On the same afternoon these resolutions of Section I. were submitted to the Chamber of Government Delegates to the Congress and adopted, and finally, at the closing meeting of the Congress on Saturday, August 25th, the action which had been taken in the matter was formally reported by M. Paul Janet, one of the two secretaries of the Congress.

THE PROPOSED NATIONAL STANDARDS BUREAU.

THE American Philosophical Society has adopted the following resolution in regard to the proposed National Standards Bureau:

Whereas, In the conduct of accurate scientific investigations, the use of apparatus of guaranteed accuracy is a need recognized by all scientists; and

Whereas, In foreign countries, notably in Germany, in France, and in England, such guarantee is furnished by standardizing bureaux under the control of the respective governments; and

Whereas, At present the United States Office of Standard Weights and Measures does not possess appliances necessary for this verification of as wide a range of apparatus as seems essential, nor the working force required to comply with legitimate demands for the verification and stamping of the various scientific apparatus designed for measurements of precision, thus compelling the importation of foreign-made articles when such official certification is desired; and

Whereas, This state of affairs is not only unsatisfactory to all investigators in both pure and applied science, but also works injustice to our manufacturers of nearly all physical and chemical apparatus designed for accurate measurement, who cannot supply the proper certification with such instruments: therefore be it

Resolved, That the Congress of the United States be urged to establish a National Standards Bureau, in connection with the U. S. Office of Standard Weights and Measures, which shall provide adequate facilities for making such verification of scientific measuring apparatus and stamping the same as are provided by foreign governments for similar work.

Resolved, further, that a copy of the foregoing be forwarded to the Secretary of the Treasury, under whose control the present office of Standard Weights and Measures comes; to the Superintendent of the U. S. Coast and Geodetic Survey; to the President of the U. S. Senate; to the Speaker of the United States House of Representatives; to the Chairman and members of the Committee on Coinage, Weights and Measures, and to any other officials or individuals likely to be interested or influential, with a request for their co-operation in our efforts to secure for the U. S. Office of Standard Weights and Measures ample facilities, in point of apparatus and working force, to enable that office to comply with the requests for the verification of measuring instruments that may be made by American scientific workers.

SCIENTIFIC NOTES AND NEWS.

Dr. William T. Harris, United States Commissioner of Education, has been awarded the grand prize of the Paris Exposition.

MM. Lacaze Duthiers and E. Mascart have been made grand officers of the French legion of honor, and MM. Henri Moissan and Troost are among those who have been made commanders. A large number of scientific men have been made officers and knights. These decorations have been conferred on the occasion of the Paris Exposition.

Professor Lamp, astronomer at the Kiel Observatory, will be absent for two years on an expedition to South Africa to determine the boundary between German East Africa and the Congo Free State.

Professor W. J. Simpson and Colonel Notter have gone to South Africa to investigate dysentery and enteric fever. Before leaving England they were inoculated against typhoid fever by Professor Wright.

The Göttingen Society of Sciences has made the following awards: To Professor F. Klein 800 Marks for the Mathematical Encyclopædia and 500 Marks for the preparation of kinematic models, and 500 Marks to Professor Wiechert for the construction of seismological recording instruments.

Following the banquet given to Lord Lister by the Paris Scientia Club a banquet was given to Lord Kelvin at which M. Oliver presided and speeches were made by MM. Mascart and Cornu to which Lord Kelvin replied.

Professor Giard, director of the biological station at Wimereux, has been elected Knight of the Order of Leopold by the Belgian government.

It is stated in *Nature* that Professor J. C. Bose, who has been attending the recent International Congress of Physics at Paris as the delegate of the Government of Bengal, proposed to attend the British Association meeting at Bradford in the same capacity, and would there describe some electrical investigations with which he has lately been engaged.

Sir W. McGregor, M.D., C.B., Governor of Lagos, will deliver the opening address at the London School of Tropical Medicine in October.

Dr. Domingo Fraire known for his work on the yellow fever bacillus has died at Rio Janeiro, at the age of 50 years.

Under the auspices of the Ottawa Field-Naturalists' Club last fall a movement was inaugurated with the object of perpetuating, in some visible and tangible manner, the memory of Elkanah Billings, who died some 24 years ago. He conducted the *Canadian Naturalist and Geologist* for several years, first in Ottawa, but later in Montreal, whither Sir William Logan had induced him to go and join him in investigating the geological resources of old Canada (Quebec and Ontario). For twenty years Mr. Billings labored in the Survey, and by his good work achieved reputation as a paleontologist and a geologist. The memorial will take the form of a portrait painted by Mr. Charles E. Moss, which will be presented to the Geological Survey Department and placed in the museum near the collections made by Billings. Subscriptions towards the memorial may be sent to Dr. H. M. Ami, Geological Survey Department, Ottawa, Can.

The International Congress of Hygiene was held in Paris from August 10th–17th with more than 1600 members in attendance. Professor Brouardel, dean of the faculty of medicine in Paris, presided, with honorary presidents from the different nations as follows: Dr. Calleja (Spain), Dr. Köhler (Germany), Dr. Pagliani (Italy), Professor Corfield (Great Britain), Dr. Van Trama-Sternegg (Austria), Dr. Bartolette (United States), Dr. Borup (Denmark). The Congress met in nine sections to which over fifty reports were presented for discussion.

The fourteenth International Medical Congress will be held at Madrid during the spring of 1903 and will be under the presidency of Professor Julien Calleja, dean of the Faculty of Medicine.

The twelfth International Congress of Anthropology and Historic Archæology opened at Paris on August 20th under the presidency of M. Bertrand.

The next international Congress of Mathematicians will be held in Germany in the summer of 1904. The place has not yet been definitely decided upon.

The Royal Saxon Antiquarian Society of Dresden celebrated its seventy-fifth anniversary on September 26th.

A Pasteur Institute has been opened at Kasauli, a hill station in the Punjab district of India, about thirty miles from Simla.

The University of Aberdeen has received from Miss Cruikshank botanical gardens, 6 acres in extent, with an endowment of £15,000. The gift is made in memory of her brother Dr. Alexander Cruikshank.

The *Botanical Gazette* states that the private herbarium of Harry N. Patterson, of Oquawka, Illinois, containing about 30,000 sheets, has been secured by the Field Columbian Museum, and will be installed with the rapidly growing collections of that institution as promptly as the careful cataloguing practiced in all departments will admit. The botanical department of the museum is to be congratulated upon this accession of one of the notable private herbaria of the country ; one that will add a complete collection of Pringle's Mexican plants to its already excellent representation of the flora of that region and the Antillean islands. Mr. Patterson's herbarium is more or less contemporaneous with that of the late Mr. Bebb which the museum secured some three years ago, and as Mr. Patterson made it his aim to secure a complete series of the species of North America, its addition to the collections of the museum will be of great value to botanical students and specialists in the west.

Dr. L. A. Bauer, in charge of the magnetic work of the U. S. Coast and Geodetic Survey, has left Washington for a three month's trip to Alaska and the Hawaiian Islands, in order to select the sites for the magnetic observatories in those regions. A third magnetic observatory, known as the Principal Magnetic Base Station, is now being built sixteen miles southeast of Washington, D. C., and a fourth observatory is at present in operation at Baldwin, Kansas, centrally situated to the area now being surveyed by the various magnetic parties. The last named observatory will be shifted about in the western states according to the requirements of the magnetic survey. It is the intention to have the four observatories ready in time to co-operate with the various antarctic expeditions.

Drs. L. Diehls and E. Pritzel have undertaken a botanical expedition to Australia on behalf of the Berlin Museum. They will explore the little known western parts of Australia. Also in the interests of the Berlin Museum Dr. Ule has gone to the sources of the Amazon to make botanical collections and especially to study the gutta-percha plant.

Mr. George Vanderbilt is defraying the expenses of an expedition to Java by Mr. David J. Walters of New Haven, who proposes to search for remains of *Pithecanthropus erectus*.

The daily papers report that the *Stella Polaris* with the Duke of Abruzzi and his party has returned to Norway from the Polar regions. The steamship lay for eleven months in the ice in latitude 82°, but several parties proceeded further with sleighs and Captain Caigni, who was gone 104 days, reached latitude of 86° 33′, a little further than the point reached by Nansen in 1895. The Duke of Abruzzi was himself disabled by having two fingers frostbitten, and did not take part in the expeditions. The party appears to have suffered a good many hardships. No report has yet been received that throws any light on the possible value of the scientific results of the expedition.

In connection with the meeting of the German Colonial Society at Coblentz a prize of 3000 Marks is offered for first finding gutta-percha plants in the German colonies and transplanting them to one of the experimental stations or to the central station in Berlin.

The National Educational Association offers prizes as follows: For the best essay submitted on each of the following topics: the seating, the lighting, the heating, and the ventilating of school buildings, $200; for the second best essay submitted on each topic, $100. Each essay shall be limited to ten thousand words and shall be submitted in printed or typewritten copy without signature, but with name of the author enclosed with it in a sealed envelope. Three copies of each essay shall be submitted, and addressed to the chairman of the committee, Mr. A. R. Taylor, at Emporia, Kansas. They must be mailed not later than February 1, 1901.

THE Magellanic gold medal of the American Philosophical Society will be awarded in December to the author of the best discovery or of the most useful invention in the physical sciences presented to the Society before November 1st.

MR. J. H. PORTER, of London, has just issued the final part of Messrs. Sclater and Thomas' 'Book of Antelopes,' which completes this important zoological work. It was planned by the late Sir Victor Brooke (to whose memory it is dedicated), and most of the plates were drawn under his superintendence more than twenty years ago. After Sir Victor's death, in 1891, the present authors undertook to prepare the letter press. The four volumes of the 'Book of Antelopes' contain 100 colored plates and 121 illustrations in the text.

MR. HEINEMANN will bring out in the autumn an account of the Antarctic expedition of the *Belgica*, written by the only English-speaking member of her crew, Mr. Frederick A. Cook, who accompanied the expedition as surgeon, anthropologist and photographer.

THE Philosophical Society of the University of Vienna proposes to publish a complete catalogue of psychological literature published between 1850 and 1900.

THE Journal officiel of the Paris Exposition has published in a number containing 350 pages the list of awards made at the Paris Exposition. There were in all 75,531 exhibitors of whom 42,790 received awards. The number of each kind of prize awarded is given in the first column of the accompanying table, while in the second column is the number conferred on Americans.

Grand Prize	2,827	218
Gold Medal	8,166	486
Silver Medal	12,244	583
Bronze Medal	11,615	423
Honorable Mention	7,938	270

In the Department of Education (Group I.) 12 grand prizes were awarded to the United States for primary education, 9 for secondary education, 13 for higher education, one for agricultural education, 6 for industrial education. It is perhaps somewhat surprising that the United States should have been awarded 41 grand prizes in education, as compared with 6 in machinery and electricity.

WE announced last week the death of Dr. John Anderson and now take from the *London Times* the following facts in regard to his life: Dr. Anderson was the son of the late Mr. Thomas Anderson, secretary to the National Bank of Scotland, Edinburgh, in which city he was born in 1833. He was educated at the George-square Academy and the Hillstreet Institution, and finally at the Edinburgh University. In 1861 he took the degree of M.D. and received a gold medal for his thesis entitled 'Observations in Zoology.' Immediately after his graduation he was appointed professor of natural science in the Free Church College, Edinburgh, but he resigned the office in 1864, having been offered the curatorship of a museum which the Government of India intended to found in Calcutta, and of which the collections of the Asiatic Society of Bengal were to form the nucleus. He arrived in India in July, 1864, and in the following year was appointed superintendent of the Indian Museum. Two or three years afterwards he was also given the chair of comparative anatomy in the Medical College, Calcutta. In 1868 he was selected by the Government of India to accompany an expedition to Western China *via* British and Independent Burma, in the capacity of scientific officer. Again, in 1874, he was chosen by the Government of India to proceed once more to Western China in the same capacity as on the former expedition, and with instructions to advance from Bhamo to Shanghai. This expedition was attacked by the Chinese, and was obliged to retreat to Burma. In 1881 Dr. Anderson was sent by the trustees of the Indian Museum, Calcutta, to investigate the marine zoology of the Mergui Archipelago, off the coast of Tenasserim. In 1887 he retired from the service of the government of India. Besides numerous papers on zoology, Dr. Anderson is the author of many independent works, among them being 'A Report on the Expedition to Western China *via* Bhamo,' published by the government of India in 1871; 'Mandalay to Momien,' an account of the two expeditions to Western China under Colonel Sir Edward Sladen and Colonel Horace Browne;

'Anatomical and Zoological Researches,' including an account of the zoological results of the two expeditions to Western China in 1868–69 and 1875. The scientific results of his researches in the Mergui Archipelago were published by the Linnean Society of London, and he also published in 1890 an account of 'English Intercourse with Siam in the Seventeenth Century,' as one of Trübner's Oriental Series. In addition to being a fellow of many learned societies he was also a Fellow of the Calcutta University and a corresponding Fellow of the Ethnological Society of Italy. In 1885 the University of Edinburgh conferred on him the honorary degree of LL.D. In 1896 Dr. Anderson published a small volume on 'The Herpetology of Arabia,' and he was lately engaged on a work dealing with 'The Fauna of Egypt.'

UNIVERSITY AND EDUCATIONAL NEWS.

Harvard University, Radcliffe College and the Massachusetts Institute of Technology each receive $2000 by the will of Barthold Schlesinger, of Brookline, Mass.

Mr. John D. Rockefeller has given $180,000 to Spellman Seminary, a Baptist college for negroes at Atlanta, Ga.

The Corporation of Harvard University has passed the following minute in acknowledgment of the gift of $100,000 made through Mr. Alexander Agassiz from Mr. and Mrs. Quincy A. Shaw, Mrs. Henry L. Higginson and himself for the immediate construction of the southwest corner of the Oxford street façade of the University Museum: *Voted* that the president and fellows gratefully accept this large gift on the terms and conditions named in Mr. Agassiz's letter, and hereby record their sense of the great worth of a gift which strengthens and perpetuates the precious associations with the name of Agassiz at Harvard University, and perfectly illustrates the noble use of private wealth for the promotion of public intellectual ends.

The city of Lafayette, Ind., has presented to Purdue University a 2,000,000-gallon water works pumping engine for use in the laboratory of the university. It was built in 1875 and is an excellent example of the duplex walking-beam pump. In addition to its historical value it will furnish an ample supply of water for the hydraulic experiments which will be carried on.

Smith College will celebrate the 25th anniversary of its foundation on October 2d and 3d. On the latter day historical addresses will be made by the Rev. Dr. John M. Greene, and President Seelye, and there will be an educational conference, with addresses by Dr. William T. Harris, United States Commissioner of Education; Dean Le Baron Russell Briggs, of Harvard University; President Arthur M. Hadley, of Yale University; President Seth Low, of Columbia University; President James M. Taylor, of Vassar College; President Caroline Hazard, of Wellesley College, and President M. Carey Thomas, of Bryn Mawr College.

Professor J. G. McGregor, of Dalhousie University, Halifax (N. S.), has been appointed professor of physics in the University College, Liverpool, in succession to Professor Lodge.

Dr. F. E. Bolton, of the Milwaukee State Normal School, has been elected professor of pedagogy in the State University of Iowa.

Dr. Walter Francis Wilcox has been appointed lecturer on the United States Census of 1900, at Harvard University.

Professor Rush Rhees, the new president of the University of Rochester, is to be formally installed on Oct. 11th.

The Crown appointments on the Senate of the University of London are: Sir John Wolfe-Barry, Sir Henry Roscoe, Mrs. Henry Sidgwick, and the Hon. W. Pember Reeves, and, as a representative of the faculty of laws, Lord Davey.

Dr. Adolf Sauer, associate professor at Heidelberg, has been elected professor of mineralogy and geology and director of the newly established geological bureau at Stuttgart.

Dr. Tchermack, docent at Leipzig, has been appointed assistant in the physiological laboratory at Halle.

Dr. Abegg, docent in chemistry at Breslau, has been promoted to an associate professorship. At the same university Dr. Emil Bose has qualified as docent in physics.

SCIENCE

Friday, September 21, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

ADDRESS OF THE PRESIDENT OF THE MATHEMATICAL AND PHYSICAL SECTION OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

It is fitting that before entering upon the business of the Section we should pause to take note of the losses which our department of science has recently sustained. The fame of Bertrand, apart from his official position as Secretary of the French Academy of Sciences, was long ago universally established by his classical treatise on the 'Infinitesimal Calculus': it has been of late years sustained by the luminous exposition and searching criticism of his books on the 'Theory of Probability' and 'Thermodynamics' and 'Electricity.' The debt which we owe to that other veteran, G. Wiedemann, both on account of his own researches, which take us back to the modern revival of experimental physics, and for his great and indispensable thesaurus of the science of electricity, cannot easily be overstated. By the death of Sophus Lie, following soon after his return to a chair in his native country Norway, we have lost one of the great constructive mathematicians of the century, who has in various directions fundamentally expanded the methods and conceptions of analysis by reverting to the fountain of direct geometrical intuition. In Italy the death of Beltrami has removed an investigator whose influence has been equally marked on the theories of transcendental geometry and on the progress of mathematical physics. In our own country we have lost in D. E. Hughes one of the great scientific inventors of the age ; while we specially deplore the removal in his early prime, of one who has recently been well known at these meetings, Thomas Preston, whose experimental investigations on the relations between magnetism and light, combined with his great powers of lucid exposition, marked out for him a brilliant future.

Perhaps the most important event of general scientific interest during the past year has been the definite undertaking of the great task of the international coordination of scientific literature ; and it may be in some measure in the prolonged conferences that were necessitated by that object that the recently announced international federation of scientific academies has had its origin. In the important task of rendering accessible the stores of scientific knowledge, the British Association, and in particular this Section of it, has played the part of pioneer. Our annual volumes have long been classical, through the splendid reports of progress of the different branches of knowledge that have been from time to time contributed to them by the foremost British men of science ; and our work in this direction has received the compliment of successful imitation by the sister Associations on the Continent.

The usual couferences connected with our department of scientific activity have been this year notably augmented by the very successful international congresses of mathematicians and of physicists which met a few weeks ago in Paris. The three volumes of reports on the progress of physical science during the last ten years, for which we are indebted to the initiative of the French Physical Society, will provide an admirable conspectus of the present trend of activity, and form a permanent record for the history of our subject.

Another very powerful auxiliary to progress is now being rapidly provided by the republication, in suitable form and within reasonable time, of the collected works of the masters of our science. We have quite recently received, in a large quarto volume, the mass of most important unpublished work that was left behind him by the late Professor J. C. Adams ; the zealous care of Professor Sampson has worked up into order the more purely astronomical part of the volume ; while the great undertaking, spread over many years, of the complete determination of the secular change of the magnetic condition of the earth, for which the practical preparations had been set on foot by Gauss himself, has been prepared for the press by Professor W. G. Adams. By the publication of the first volume of Lord Rayleigh's papers a series of memoirs which have formed a main stimulus to the progress of mathematical physics in this country during the past twenty years has become generally accessible. The completed series will form a landmark for the end of the century that may be compared with Young's 'Lectures on Natural Philosophy' for its beginning.

The recent reconstruction of the University of London and the foundation of the University of Birmingham will, it is to be hoped, give greater freedom to the work of our University Colleges. The system of examinations has formed an admirable stimulus to the effective acquisition of that general knowledge which is a necessary part of all education. So long as the examiner recognizes that his function is a responsible and influential one, which is to be taken seriously from the point of view of moulding the teaching in places where external guidance is helpful, test by examination will remain a most valuable means of extending the area of higher education. Except for workers in rapidly progressive branches of technical science, a broad education seems better adapted to the purposes of life than special training over a narrow range; and it is difficult to see how a reasonably elastic examination test can be considered as a hardship. But the case is changed when preparation for a specialized scientific profession, or mastery of the lines of attack in an unsolved problem, is the object. The general education has then been presumably finished; in expanding departments of knowledge, variety rather than uniformity of training should be the aim, and the genius of a great teacher should be allowed free play without external trammels. It would appear that in this country we have recently been liable to unduly mix up two methods. We have been starting students on the special and lengthy, though very instructive, processes which are known as original research at an age when their time would be more profitably employed in rapidly acquiring a broad basis of knowledge. As a result, we have been extending the examination test from the general knowledge to which it is admirably suited into the specialized activity which is best left to the stimulus of personal interest. Informal contact with competent advisers, themselves imbued with the scientific spirit, who can point the way towards direct appreciation of the works of the masters of the science, is far more effective than detailed instruction at second hand, as regards growing subjects that have not yet taken on an authoritative form of exposition. Fortunately there seems to be now no lack of such teachers to meet the requirements of the technical colleges that are being established throughout the country.

The famous treatise which opened the modern era by treating magnetism and electricity on a scientific basis appeared just 300 years ago. The author, William Gilbert, M.D., of Colchester, passed from the Grammar School of his native town to St. John's College, Cambridge; soon after taking his first degree, in 1560, he became a Fellow of the College, and seems to have remained in residence, and taken part in its affairs, for about ten years. All through his subsequent career, both at Colchester and afterwards at London, where he attained the highest position in his profession, he was an exact and diligent explorer, first of chemical and then of magnetic and electric phenomena. In the words of the historian Hallam, writing in 1839, 'in his Latin treatise on the 'Magnet,' he not only collected all the knowledge which others had possessed, but he became at once the father of experimental philosophy in this island'; and no demur would be raised if Hallam's restriction to this country were removed. Working nearly a century before the time when the astronomical discoveries of Newton had originated the idea of attraction at a distance, he established a complete formulation of the interaction of magnets by what we now call the exploration of their fields of force. His analysis of the facts of magnetic influence, and incidentally of the points in which it differs from electric influence, is virtually the one which Faraday reintroduced. A cardinal advance was achieved, at a time when the Copernican Astronomy had still largely to make its way by assigning the behavior of the compass and the dip needle to the fact that the earth itself is a great magnet, by whose field of influence they are controlled. His book passed through many editions on the Continent within forty years; it won the high praise of Galileo. Gilbert has been called 'the father of modern electricity' by Priestley, and 'the Galileo of magnetism' by Poggendorff.

When the British Association last met at Bradford in 1873, the modern theory which largely reverts to Gilbert's way of formulation, and refers electric and magnetic phenomena to the activity of the æther instead of attractions at a distance, was of recent growth; it had received its classical exposition only two years before by the publication of Clerk Maxwell's treatise. The new doctrine was already widely received in England on its own independent merits. On the Continent it was engaging the strenuous attention of Helmholtz, whose series of memoirs, deeply probing the new ideas in their relation to the prevalent and fairly successful theories of direct action across space, had begun to appear in 1870. During many years the search for crucial experiments that would go beyond the results equally explained by both views, met with small success; it was not until 1887 that Hertz, by the discovery of the æthereal radiation of long wave-length emitted from electric oscillators, verified the hypothesis of Faraday and Maxwell and initiated a new era in the practical development of physical science. The experimental field thus opened up was soon fully occupied both in this country and abroad; and the borderland between the sciences of optics and electricity is now being rapidly explored. The extension of experimental knowledge was simultaneous with increased attention to directness of explanation; the expositions of Heaviside and Hertz and other writers fixed attention in a manner already briefly exemplified by Maxwell himself, on the inherent simplicity of the completed æthereal scheme, when once the theoretical scaffolding employed in its construction and dynamical consolidation is removed; while Poynting's beautiful corollary specifying the path of the transmission of energy through the æther has brought the theory into simple relations with the applications of electrodynamics.

Equally striking has been the great mastery obtained during the last twenty years over the practical manipulation of electric power. The installation of electric wires as the nerves connecting different regions of the earth had attained the rank of accomplished fact so long ago as 1857, when the first Atlantic cable was laid. It was largely the theoretical and practical difficulties, many of them unforeseen, encountered in carrying that great undertaking to a successful issue, that necessitated the elaboration by Lord Kelvin and his coadjutors, of convenient methods and instruments for the exact measurement of electric quantities, and thus prepared the foundation for the more recent practical developments in other directions. On the other hand, the methods of theoretical explanation have been in turn improved and simplified through the new ways of considering the phenomena which have been evolved in the course of practical advances on a large scale, such as the improvement of dynamo armatures, the conception and utilization of magnetic circuits, and the transmission of power by alternating currents. In our time the relations of civilized life have been already perhaps more profoundly altered than ever before, owing to the establishment of practically instantaneous electric communication between all parts of the world. The employment of the same subtle agency is now rapidly superseding the artificial reciprocating engines and other contrivances for the manipulation of mechanical power that were introduced with the employment of steam. The possibilities of transmitting power to great distances at enormous tension, and therefore with very slight waste, along lines merely suspended in the air, are being practically realized; and the advantages thence derived are increased many fold by the almost automatic manner in which the electric power can be transformed into mechanical rotation at the very point where it is desired to apply it. The energy is transmitted at such lightning speed that at a given instant only an exceedingly minute portion of it is in actual transit. When the tension of the alternations is high, the amount of electricity that has to oscillate backwards and forwards on the guiding wires is proportionately diminished, and the frictional waste reduced. At the terminals the direct transmission from one armature of the motor to the other, across the intervening empty space, at once takes us beyond the province of the pushing and rubbing contacts that are unavoidable in mechanical transmission ; while the perfect symmetry and reversibility of the arrangement by which power is delivered from a rotatory alternator at one end, guided by the wires to another place many miles away, where it is absorbed by another alternator with precise reversal of the initial stages, makes this process of distribution of energy resemble the automatic operations of nature rather than the imperfect material connections previously in use. We are here dealing primarily with the flawless continuous medium which is the transmitter of radiant energy across the celestial spaces; the part played by the coarsely constituted material conductor is only that of a more or less imperfect guide which directs the current of æthereal energy. The wonderful nature of this theoretically perfect, though of course practically only approximate, method of abolishing limitations of locality with regard to mechanical power is not diminished by the circumstance that its principle must have been in some manner present to the mind of the first person who fully realized the character of the reversibility of a gramme armature.

In theoretical knowledge a new domain, to which the theory as expounded twenty years ago had little to say, has recently been acquired through the experimental scrutiny of the electric discharge in rarefied gaseous media. The very varied electric phenomena of vacuum tubes, whose electrolytic character was first practically established by Schuster, have been largely reduced to order through the employment of the high exhaustions introduced and first utilized by Crookes. Their study under these circumstances, in which the material molecules are so sparsely distributed as but rarely to interfere with each other, has conduced to enlarged knowledge and verification of the fundamental relations in which the individual molecules stand to all electric phenomena, culminating recently in the actual determination, by J. J. Thomson and others following in his track, of the masses and velocities of the particles that carry the electric discharge across the exhausted space. The recent investigations of the circumstances of the electric dissociation produced in the atmosphere and in other gases by ultra-violet light, the Röntgen radiation, and other agencies, constitute one of the most striking developments in experimental molecular physics since Graham determined the molecular relations of gaseous diffusion and transpiration more than half a century ago. This advance in experimental knowledge of molecular phenomena, assisted by the discovery of the precise and rational effect of magnetism on the spectrum, has brought into prominence a modification or rather development of Maxwell's exposition of electric theory, which was dictated primarily by the requirements of the abstract theory itself; the atoms or ions are now definitely introduced as the carriers of those electric charges which interact across the æther, and so produce the electric fields whose transformations were the main subject of the original theory.

We are thus inevitably led, in electric and æthereal theory, as in the chemistry and dynamics of the gaseous state which is the department of abstract physics next in order of simplicity, to the consideration of the individual molecules of matter. The theoretical problems which had come clearly into view a quarter of a century ago, under Maxwell's lead, whether in the exact dynamical relations of æthereal transmission or in the more fortuitous domain of the statistics of interacting molecules, are those around which attention is still mainly concentrated; but as the result of the progress in each, they are now tending towards consolidation into one subject. I propose—leaving further review of the scientific aspect of the recent enormous development of the applications of physical science for hands more competent to deal with the practical side of that subject—to offer some remarks on the scope and validity of this molecular order of ideas, to which the trend of physical explanation and development is now setting in so pronounced a manner.

If it is necessary to offer an apology for detaining the attention of the Section on so abstract a topic, I can plead its intrinsic philosophical importance. The hesitation so long felt on the Continent in regard to discarding the highly developed theories which analyzed all physical actions into direct attractions between the separate elements of the bodies concerned, in favor of a new method in which our ideas are carried into regions deeper than the phenomena, has now given place to eager discussion of the potentialities of the new standpoint. There has even appeared a disposition to consider that the Newtonian dynamical principles, which have formed the basis of physical explanation for nearly two centuries, must be replaced in these deeper subjects by a method of direct description of the mere course of phenomena, apart from any attempt to establish causal relations; the initiation of this method being traced, like that of the Newtonian dynamics itself, to this country. The question has arisen as to how far the new methods of æthereal physics are to be considered as an independent departure, how far they form the natural development of existing dynamical science. In England, whence the innovation came, it is the more conservative position that has all along been occupied. Maxwell was himself trained in the school of physics established in this country by Sir George Stokes and Lord Kelvin, in which the dominating idea has been that of the strictly dynamical foundation of all physical action. Although the pupil's imagination bridged over dynamical chasms, across which the master was not always able to follow, yet the most striking feature of Maxwell's scheme was still the dynamical framework into which it was built. The more advanced reformers have now thrown overboard the apparatus of potential functions which Maxwell found necessary for the dynamical consolidation of his theory, retaining only the final result as a verified descriptive basis for the phenomena. In this way all difficulties relating to dynamical development and indeed consistency are avoided, but the question remains as to how much is thereby lost. In practical electromagnetics the transmission of power is now the most prominent phenomenon; if formal dynamics is put aside in the general theory, its guidance must here be replaced by some more empirical and tentative method of describing the course of transmission and transformation of mechanical energy in the system.

The direct recognition in some form, either explicitly or tacitly, of the part played by the æther has become indispensable to the development and exposition of general physics ever since the discoveries of Hertz left no further room for doubt that this physical scheme of Maxwell was not merely a brilliant speculation, but constituted, in spite of outstanding gaps and difficulties, a real formulation of the underlying unity in physical dynamics. The domain of abstract physics is in fact roughly divisible into two regions. In one of them we are mainly concerned with interactions between one portion of matter and another portion occupying a different position in space; such interactions have very uniform and comparatively simple relations; and the reason is traceable to the simple and uniform constitution of the intervening medium in which they have their seat. The other province is that in which the distribution of the material molecules comes into account. Setting aside the ordinary dynamics of matter in bulk, which is founded on the uniformity of the properties of the bodies concerned and their experimental determination, we must assign to this region all phenomena which are concerned with the uncoordinated motions of the molecules, including the range of thermal and in part of radiant actions; the only possible basis for detailed theory is the statistical dynamics of the distribution of the molecules. The far more deep-seated and mysterious processes which are involved in changes in the constitution of the individual molecules themselves are mainly outside the province of physics, which is competent to reason only about permanent material systems; they must be left to the sciences of chemistry and physiology. Yet the chemist proclaims that he can determine only the results of his reactions and the physical conditions under which they occur; the character of the bonds which hold atoms in their chemical combinations is at present unknown, although a large domain of very precise knowledge relating, in some diagrammatic manner, to the topography of the more complex molecules has been attained. The vast structure which chemical science has in this way raised on the narrow foundation of the atomic theory is perhaps the most wonderful existing illustration both of the rationality of natural processes and of the analytical powers of the human mind. In a word, the complication of the material world is referable to the vast range of structure and of states of aggregation in the material atoms; while the possibility of a science of physics is largely due to the simplicity of constitution of the universal medium through which the individual atoms interact on each other.

The reference of the uniformity in the interactions at a distance between material bodies to the part played by the æther is a step towards the elimination of extraneous and random hypotheses about laws of attraction between atoms. It also places that medium on a different basis from matter, in that its mode of activity is simple and regular, whereas intimate material interactions must be of illimitable complexity. This gives strong ground for the view that we should not be tempted towards explaining the simple group of relations which have been found to define the activity of the æther, by treating them as mechanical consequences of concealed structure in that medium; we should rather rest satisfied with having attained to their exact dynamical correlation, just as geometry explores or correlates, without explaining, the descriptive and metric properties of space. On the other hand, a view is upheld which considers the pressures and thrusts of the engineer, and the strains and stresses in the material structures by which he transmits them from one place to another, to be the archetype of the processes by which all mechanical effect is transmitted in nature. This doctrine implies an expectation that we may ultimately discover something analogous to structure in the celestial spaces, by means of which the transmission of physical effect will be brought into line with the transmission of mechanical effect by material frame work.

At a time when the only definitely ascertained function of the æther was the undulatory propagation of radiant energy across space, Lord Kelvin pointed out that, by reason of the very great velocity of propagation, the density of the radiant energy in the medium at any place must be extremely small in comparison with the amount of energy that is transmitted in a second of time: this easily led him to the very striking conclusion that, on the hypothesis that the æther is like material elastic media, it is not necessary to assume its density to be more than 10^{-18} of that of water, or its optical rigidity to be more than ten 10^{-8} of that of steel or glass. Thus far the æther would be merely an impalpable material atmosphere for the transference of energy by radiation, at extremely small densities but with very great speed, while ordinary matter would be the seat of practically all this energy. But this way of explaining the absence of sensible influence of the æther on the phenomena of material dynamics lost much of its basis as soon as it was recognized that the same medium must be the receptacle of very high densities of energy in the electric fields around currents and magnets.* The other mode of explanation is to consider the æther to be of the very essence of all physical actions, and to correlate the absence of obvious mechanical evidence of its intervention with its regularity and universality.

On this plan of making the æther the essential factor is the transformation of energy as well as its transmission across space, the material atom must be some kind of permanent nucleus that retains around itself an æthereal field of physical influence, such as, for example, a field of strain. We can recognize the atom only through its interactions with other atoms that are so far away from it as to be practically independent systems; thus our direct knowledge of the atom will be confined to this field of force which belongs to it. Just as the exploration of the distant field of magnetic influence of a steel magnet, itself concealed from view, cannot tell us anything about the magnet except the amount and direction of its moment, so a practically complete knowledge of the field of physical influence of an atom might be expressible in terms of the numerical values of a limited number of physical moments associated with it, without any revelation as to its essential structure or constitution being involved. This will at any rate be the case for ultimate atoms if, as is most likely, the distances at which they are kept apart are large compared with the diameters of the atomic nuclei; it in fact forms our only chance for penetrating to definite dynamical views of molecular structure. So long as we cannot isolate a single molecule, but must deal observationally with an innumerable distribution of them, even this kind of knowledge will be largely confined to average values. But the last half-century has witnessed the successful application of a new instrument of research, which has removed in various directions the limitations that had previously been placed on the knowledge to which it was possible for human effort to look forward. The spectroscope has created a new astronomy by revealing the constitutions and the unseen internal motions of the stars. Its power lies in the fact that it does take hold of the internal relations of the individual molecule of matter, and provides a very definite and detailed, though far from complete, analysis of the vibratory motions

* We can here only allude to Lord Kelvin's recent most interesting mechanical illustrations of a solid æther interacting with material molecules and with itself by attraction at a distance: unlike the generalized dynamical methods expounded in the text, which can leave the intimate structure of the material molecule outside the problem, a definite working constitution is there assigned to the molecular nucleus. It is pointed out in a continuation that is to appear in the *Philosophical Magazine* for September, that a density of æther of the order of only 10^{-9}, which would not appreciably affect the inertia of matter, would involve rigidity comparable with that of steel, and thus permit transmission of magnetic forces by stress; this solid æther is, however, as usual, taken to be freely permeable to the molecules of matter.

that are going on in it; these vibrations being in their normal state characteristic of its dynamical constitution, and in their deviations from the normal giving indications of the velocity of its movement and the physical state of its environment. Maxwell long ago laid emphasis on the fact that a physical atomic theory is not competent even to contemplate the vast mass of potentialities and correlations of the past and the future, that biological theory has to consider as latent in a single organic germ containing at most only a few million molecules. On our present view we can accept his position that the properties of such a body cannot be those of a 'purely material system,' provided, however, we restrict this phrase to apply to physical properties as here defined. But an exhaustive discovery of the intimate nature of the atom is beyond the scope of physics; questions as to whether it must not necessarily involve in itself some image of the complexity of the organic structures of which it can form a correlated part must remain a subject of speculation outside the domain of that science. It might be held that this conception of discrete atoms and continuous æther really stands, like those of space and time, in intimate relation with our modes of mental apprehension, into which any consistent picture of the external world must of necessity be fitted. In any case it would involve abandonment of all the successful traditions of our subject if we ceased to hold that our analysis can be formulated in a consistent and complete manner, so far as it goes, without being necessarily an exhaustive account of phenomena that are beyond our range of experiment. Such phenomena may be more closely defined as those connected with the processes of intimate combination of the molecules: they include the activities of organic beings which all seem to depend on change of molecular structure.

If, then, we have so small a hold on the intimate nature of matter, it will appear all the more striking that physicists have been able precisely to divine the mode of operation of the intangible æther, and to some extent explore in it the fields of physical influence of the molecules. On consideration we recognize that this knowledge of fundamental physical interaction has been reached by a comparative process. The mechanism of the propagation of light could never have been studied in the free æther of space alone. It was possible, however, to determine the way in which the characteristics of optical propagation are modified, but not wholly transformed, when it takes place in a transparent material body instead of empty space. The change in fact arises on account of the æther being entangled with the network of material molecules; but inasmuch as the length of a single wave of radiation covers thousands of these molecules the wave-motion still remains uniform and does not lose its general type. A wider variation of the experimental conditions has been provided for our examination in the case of those substances in which the phenomenon of double refraction pointed to a change of the æthereal properties which varied in different directions; and minute study of this modification has proved sufficient to guide to a consistent appreciation of the nature of this change, and therefore of the mode of æthereal propagation that is thus altered. In the same way, it was the study and development of the manner in which the laws of electric phenomena in material bodies had been unraveled by Ampère and Faraday, that guided Faraday himself and Maxwell—who were impressed with the view that the æther was at the bottom of it all—in their progress towards an application of similar laws to æther devoid of matter, such as would complete a scheme of continuous action by consistently interconnecting the material bodies and banishing all untraced interaction across empty space. Maxwell in fact chose to finally expound the theory by ascribing to the æther of free space a dielectric constant and a magnetic constant of the same type as had been found to express the properties of material media, thus extending the seat of the phenomena to all space on the plan of describing the activity of the æther in terms of the ordinary electric ideas. The converse mode of development, starting with the free æther under the directly dynamical form which has been usual in physical optics, and introducing the influence of the material atoms through the electric charges which are involved in their constitution,* was hardly employed by him; in part, perhaps, because, owing to the necessity of correlating his theory with existing electric knowledge and the mode of its expression, he seems never to have reached the stage of moulding it into a completely deductive form.

The dynamics of the æther, in fact the recognition of the existence of an æther, has thus, as a matter of history, been reached through study of the dynamical phenomena of matter. When the dynamics of a material system is worked up to its purest and most general form, it becomes a formulation of the relations between the succession of the configurations and states of motion of the system, the assistance of an independent idea of force not being usually required. We can, however, only attain such a compact statement when the system is self-contained, when its motion is not being dissipated by agencies of frictional type, and when its connections can be directly specified by purely geometrical relations between the co-ordinates, thus excluding such mechanisms as rolling contacts. The course of the system is then in all cases determined by some form or other of a single fundamental property, that any alteration in any small portion of its actual course must produce an increase in the total 'Action' of the motion. It is to be observed that in employing this law of minimum as regards the Action expressed as an integral over the whole time of the motion, we no more introduce the future course as a determining influence on the present state of motion than we do in drawing a straight line from any point in any direction, although the length of the line is the minimum distance between its ends. In drawing the line piece by piece we have to make tentative excursions into the immediate future in order to adjust each element into straightness with the previous element; so in tracing the next stage of the motion of a material system we have similarly to secure that it is not given any such directions as would unduly increase the Action. But whatever views may be held as to the ultimate significance of this principle of action, its importance, not only for mathematical analysis, but as a guide to physical exploration, remains fundamental. When the principles of the dynamics of material systems are refined down to their ultimate common basis, this principle of minimum is what remains. Hertz preferred to express its contents in the form of a principle of straightness of course or path. It will be recognized, on the lines already indicated, that this is another mode of statement of the same fundamental idea; and the general equivalence is worked out by Hertz on the basis of Hamilton's development of the principles of dynamics. The latter mode of statement may be adaptable so as to avoid

* In 1870 Maxwell, while admiring the breadth of the theory of Weber, which is virtually based on atomic charges combined with action at a distance, still regarded it as irreconcilable with his own theory, and left to the future the question as to why 'theories apparently so fundamentally opposed should have so large a field of truth common to both.'—*Scientific Papers*, II., p. 228.

the limitations which restrict the connections of the system, at the expense, however, of introducing new variables ; if, indeed, it does not introduce gratuitous complexity for purposes of physics to attempt to do this. However these questions may stand, this principle of straightness or directness of path forms, whenever it applies, the most general and comprehensive formulation of purely dynamical action : it involves in itself the complete course of events. In so far as we are given the algebraic formula for the time-integral which constitutes the Action, expressed in terms of any suitable coordinates, we know implicitly the whole dynamical constitution and history of the system to which it applies. Two systems in which the Action is expressed by the same formula are mathematically identical, are physically precisely correlated, so that they have all dynamical properties in common. When the structure of a dynamical system is largely concealed from view, the safest and most direct way towards an exploration of its essential relations and connections, and in fact towards answering the prior question as to whether it is a purely dynamical system at all, is through this order of ideas. The ultimate test that a system is a dynamical one is not that we shall be able to trace mechanical stresses throughout it, but that its relations can be in some way or other consolidated into accordance with this principle of minimum Action. This definition of a dynamical system in terms of the simple principle of directness of path may conceivably be subject to objection as too wide ; it is certainly not too narrow ; and it is the conception which has naturally been evolved from two centuries of study of the dynamics of material bodies. Its very great generality may lead to the objection that we might completely formulate the future course of a system in its terms, without having obtained a working familiarity with its details of the kind to which we have become accustomed in the analysis of simple material systems ; but our choice is at present between this kind of formulation, which is a real and essential one, and an empirical description of the course of phenomena combined with explanations relating to more or less isolated groups. The list of great names, including Kelvin, Maxwell, Helmholtz, that have been associated with the employment of the principle for the elucidation of the relations of deep-seated dynamical phenomena, is a strong guarantee that we shall do well by making the most of this clue.

Are we then justified in treating the material molecule, so far as revealed by the spectroscope, as a dynamical system coming under this specification ? Its intrinsic energy is certainly permanent and not subject to dissipation ; otherwise the molecule would gradually fade out of existence. The extreme precision and regularity of detail in the spectrum shows that the vibrations which produce it are exactly synchronous whatever be their amplitude, and in so far resemble the vibrations of small amplitude in material systems. As all indications point to the molecule being a system in a state of intrinsic motion, like a vortex ring, or a stellar system in astronomy, we must consider these radiating vibrations to take place around a steady state of motion which does not itself radiate, not around a state of rest. Now not the least of the advantages possessed by the Action principle, as a foundation for theoretical physics, is the fact that its statement can be adapted to systems involving in their constitution permanent steady motions of this kind, in such a way that only the variable motions superposed on them come into consideration. The possibilities as regards physical correlation of thus introducing permanent motional states as well as permanent structure into the constitution of our dynamical systems have long been emphasized by Lord Kelvin;* the effective adaptation of abstract dynamics to such systems was made independently by Kelvin and Routh about 1877; the more recent exposition of the theory by Helmholtz has directed general attention to what is undoubtedly the most significant extension of dynamical analysis which has taken place since the time of Lagrange.

Returning to the molecules, it is now verified that the Action principle forms a valid foundation throughout electrodynamics and optics; the introduction of the æther into the system has not affected its application. It is therefore a reasonable hypothesis that the principle forms an allowable foundation for the dynamical analysis of the radiant vibrations in the system formed by a single molecule and surrounding æther; and the knowledge which is now accumulating, both of the orderly grouping of the lines of the spectrum and of the modifications impressed on these lines by a magnetic field or by the density of the matter immediately surrounding the vibrating molecule, can hardly fail to be fruitful for the dynamical analysis of its constitution. But let it be repeated that this analysis would be complete when a formula for the dynamical energy of the molecule is obtained, and would go no deeper. Starting from our definitely limited definition of the nature of a dynamical system, the problem is merely to correlate the observed relations of the periods of vibration in a molecule, when it has come into a steady state as regards constitution and is not under the influence of intimate encounter with other molecules.

It may be recalled incidentally that the generalized Maxwell-Boltzmann principle of the equable distribution of the acquired store of kinetic energy of the molecule, among its various possible independent types of motion, is based directly on the validity of the Action principle for its dynamics. In the demonstrations usually offered the molecule is considered to have no permanent or constitutive energy of internal motion. It can, however, be shown, by use of the generalization aforesaid of the Action principle, that no discrepancy will arise on that account. Such intrinsic kinetic energy virtually adds on to the potential energy of the system; and the remaining or acquired part of the kinetic energy of the molecule may be made the subject of the same train of reasoning as before.

Let us now return to the general question whether our definition of a dynamical system may not be too wide. As a case in point, the single principle of Action has been shown to provide a definite and sufficient basis for electrodynamics; yet when, for example, one armature of an electric motor pulls the other after it without material contact, and so transmits mechanical power, no connection between them is indicated by the principle such as could by virtue of internal stress transmit the pull. The essential feature of the transmission of a pull by stress across a medium is that each element of volume of the medium acts by itself, independently of the other elements. The stress excited in any element depends on the strain or other displacement occurring in that element alone; and the mechanical effect that is transmitted is considered as an extraneous force applied at one place in the medium, and passed on from element to element through these internal pressures and tractions until it reaches another place. We have, however, to consider two atomic electric charges as being themselves some kind of strain configurations in the æther; each of them already involves an atmosphere of

* For a classical exposition see his *Brit. Assoc.* Address of 1884 on 'Steps towards a Kinetic Theory of Matter,' reprinted in 'Popular Lectures and Addresses,' vol i.

strain in the surrounding æther which is part of its essence, and cannot be considered apart from it; each of them essentially pervades the entire space, though on account of its invariable character we consider it as a unit. Thus we appear to be debarred from imagining the æther to act as an elastic connection which is merely the agent of transmission of a pull from the one nucleus to the other, because there are already stresses belonging to and constituting an intrinsic part of the terminal electrons, which are distributed all along the medium. Our action criterion of a dynamical system, in fact, allows us to reason about an electron as a single thing, notwithstanding that its field of energy is spread over the whole medium; it is only in material solid bodies, and in problems in which the actual sphere of physical action of the molecule is small compared with the smallest element of volume that our analysis considers, that the familiar idea of transmission of force by simple stress can apply. Whatever view may ultimately command itself, this question is one that urgently demands decision. A very large amount of effort has been expended by Maxwell, Helmholtz, Heaviside, Hertz and other authorities in the attempt to express the mechanical phenomena of electrical action in terms of a transmitting stress. The analytical results up to a certain point have been promising, most strikingly so at the beginning, when Maxwell established the mathematical validity of the way in which Faraday was accustomed to represent to himself the mechanical interactions across space, in terms of a tension along the lines of force equilibrated by an equal pressure preventing their expansion sideways. According to the views here developed, that ideal is an impossible one; if this could be established to general satisfaction the field of theoretical discussion would be much simplified.

This view that the atom of matter is, so far as regards physical actions, of the nature of a structure in the æther involving an atmosphere of æthereal strain all around it, not a small body which exerts direct actions at a distance on other atoms according to extraneous laws of force, was practically foreign to the eighteenth century, when mathematical physics was modelled on the Newtonian astronomy and dominated by its splendid success. The scheme of material dynamics, as finally compactly systematized by Lagrange, had therefore no direct relation to such a view, although it has proved wide enough to include it. The remark has often been made that it is probably owing to Faraday's mathematical instinct, combined with his want of acquaintance with the existing analysis, that the modern theory of the æther obtained a start from the electric side. Through his teaching and the weight of his authority, the notion of two electric currents exerting their mutual forces by means of an intervening medium, instead of by direct attraction across space, was at an early period firmly grasped in this country. In 1845 Lord Kelvin was already mathematically formulating, with most suggestive success, continuous elastic connections, by whose strain the fields of activity of electric currents or of electric distributions could be illustrated; while the exposition of Maxwell's interconnected scheme, in the earlier form in which it relied on concrete models of the electric action, goes back almost to 1860. Corresponding to the two physical ideals of isolated atoms exerting attraction at a distance, and atoms operating by atmospheres of æthereal strain, there are, as already indicated, two different developments of dynamical theory. The original Newtonian equations of motion determined the course of a system by expressing the rates at which the velocity of each of its small parts or elements is changing. This method is still fully applicable to those problems of gravitational astronomy in which dynamical explanation was first successful on a grand scale, the planets being treated as point-masses, each subject to the gravitational attraction of the other bodies. But the more recent development of the dynamics of complex systems depends on the fact that analysis has been able to reduce within manageable limits the number of varying quantities whose course is to be explicitly traced, through taking advantage of those internal relations of the parts of the system that are invariable, either geometrically or dynamically. Thus, to take the simplest case, the dynamics of a solid body can be confined to a discussion of its three components of translation and its three components of rotation, instead of the motion of each element of its mass. With the number of independent co-ordinates thus diminished when the initial state of the motion is specified the subsequent course of the complete system can be traced; but the course of the changes in any part of it can only be treated in relation to the motion of the system as a whole. It is just this mode of treatmant of a system as a whole that is the main characteristic of modern physical analysis. The way in which Maxwell analyzed the interactions of a system of linear electric currents, previously treated as if each were made up of small independent pieces or elements, and accumulated the evidence that they formed a single dynamical system, is a trenchant example. The interactions of vortices in fluid form a very similar problem, which is of special note in that the constitution of the system is there completely known in advance, so that the two modes of dynamical exposition can be compared. In this case the older method forms independent equations for the motion of each material element of the fluid, and so requires the introduction of the stress—here the fluid pressure—by which dynamical effect is passed on to it from the surrounding elements: it corresponds to a method of contact action. But Helmholtz opened up new ground in the abstract dynamics of continuous media when he recognized (after Stokes) that, if the distribution of the velocity of spin at those places in the fluid where the motion is vortical be assigned, the motion in every part of the fluid is therein kinematically involved. This, combined with the theorem of Lagrange and Cauchy, that the spin is always confined to the same portions of the fluid, formed a starting-point for his theory of vortices, which showed how the subsequent course of the motion can be ascertained without consideration of pressure or other stress.

The recognition of the permanent state of motion constituting a vortex ring as a determining agent as regards the future course of the system was in fact justly considered by Helmholtz as one of his greatest achievements. The principle had entirely eluded the attention of Lagrange and Cauchy and Stokes, who were the pioneers in this fundamental branch of dynamics, and had virtually prepared all the necessary analytical material for Helmholtz's use. The main import of this advance lay, not in the assistance which is afforded to the development of the complete solution of special problems in fluid motion, but in the fact that it constituted the discovery of the types of permanent motion of the system, which could combine and interact with each other without losing their individuality,* though each of them pervaded the whole field. This rendered possible an entirely new mode of treatment; and mathematicians who were accustomed, as in astronomy, to aim directly at the determina-

* We may compare G. W. Hill's more recent introduction of the idea of permanent orbits into physical astronomy.

tion of all the details of the special case of motion, were occasionally slow to apprehend the advantages of a procedure which stopped at formulating a description of the nature of the interaction between various typical groups of motions into which the whole disturbance could be resolved.

The new train of ideas introduced into physics by Faraday was thus consolidated and emphasized by Helmholtz's investigations of 1858 in the special domain of hydrodynamics. In illustration let us consider the fluid medium to be pervaded by permanent vortices circulating round solid rings as cores ; the older method of analysis would form equations of motion for each element of the fluid, involving the fluid pressure, and by their integration would determine the distribution of pressure on each solid ring, and thence the way it moves. This method is hardly feasible even in the simplest cases. The natural plan is to make use of existing simplifications by regarding each vortex as a permanent reality, and directly attacking the problem of its interactions with the other vortices. The energy of the fluid arising from the vortex motion can be expressed in terms of the positions and strengths of the vortices alone; and then the principle of Action, in the generalized form which includes steady motional configurations as well as constant material configurations, affords a method of deducing the motions of the cores and the interactions between them. If the cores are thin they in fact interact mechanically, as Lord Kelvin and Kirchhoff proved, in the same manner as linear electric currents would do ; though the impulse thence derived towards a direct hydro-kinetic explanation of electro-magnetics was damped by the fact that repulsion and attraction have to be interchanged in the analogy. The conception of vortices, once it has been arrived at, forms the natural physical basis of investigation, although the older method of determining a distribution of pressure-stress throughout the fluid and examining how it affects the cores is still possible ; that stress, however, is not simply transmitted, as it has to maintain the changes of velocity of the various portions of the fluid. But if the vortices have no solid cores we are at a loss to know where even this pressure can be considered as applied to them; if we follow up the stress, we lose the vortex; yet a fluid vortex can nevertheless illustrate an atom of matter, and we can consider such atoms as exerting mutual forces, only these forces cannot be considered as transmitted through the agency of fluid pressure. The reason is that the vortex cannot now be identified with a mere core bounded by a definite surface, but is essentially a configuration of motion extending throughout the medium.

Thus we are again in face of the fundamental question whether all attempts to represent the mechanical interactions of electro-dynamic systems, as transmitted from point to point by means of simple stress, are not doomed to failure ; whether they do not, in fact, introduce unnecessary and insurmountable difficulty into the theory. The idea of identifying an atom with a state of strain or motion, pervading the region of the æther around its nucleus, appears to demand wider views as to what constitutes dynamical transmission. The idea that any small portion of the primordial medium can be isolated, by merely introducing tractions acting over its surface and transmitted from the surrounding parts, is no longer appropriate or consistent; a part of the dynamical disturbance in that element of the medium is on this hypothesis already classified as belonging to, and carried along with, atoms that are outside it but in its neighborhood—and this part must not be counted twice over. The law of Poynting relating to the paths of the transmission of energy is known to hold in its simple form only when the electric charges or currents are in a steady state; when they are changing their positions or configurations their own fields of intrinsic energy are carried along with them.

It is not surprising, considering the previous British familiarity with this order of ideas, that the significance for general physics of Helmholtz's doctrine of vortices was eagerly developed in this country, in the form in which it became embodied through Lord Kelvin's famous illustration of the constitution of the matter, as consisting of atoms with separate existence and mutual interactions. This vortex atom theory has been a main source of physical suggestion because it presents, on a simple basis, a dynamical picture of an ideal material system, atomically constituted, which could go on automatically without extraneous support. The value of such a picture may be held to lie, not in any supposition that this is the mechanism of the actual world laid bare, but in the vivid illustration it affords of the fundamental postulate of physical science, that mechanical phenomena are not parts of a scheme too involved for us to explore, but rather present themselves in definite and consistent correlations, which we are able to disentangle and apprehend with continuously increasing precision.

It would be an interesting question to trace the origin of our preference for a theory of transmission of physical action over one of direct action at a distance. It may be held that it rests on the same order of ideas as supplies our conception of force; that the notion of effort which we associate with change of the motion of a body involves the idea of a mechanical connection through which that effort is applied. The mere idea of a transmitting medium would then be no more an ultimate foundation for physical explanation than that of force itself. Our choice between direct distance action and mediate transmission would thus be dictated by the relative simplicity and coherence of the accounts they give of the phenomena: this is, in fact, the basis on which Maxwell's theory had to be judged until Hertz detected the actual working of the medium. Instantaneous transmission is to all intents action at a distance, except in so far as the law of action may be more easily formulated in terms of the medium than in a direct geometrical statement.

In connection with these questions it may be permitted to refer to the eloquent and weighty address recently delivered by M. Poincaré to the International Congress of Physics. M. Poincaré accepts the principle of Least Action as a reliable basis for the formulation of physical theory, but he imposes the condition that the results must satisfy the Newtonian law of equality of action and reaction between each pair of bodies concerned, considered by themselves; this, however, he would allow to be satisfied indirectly, if the effects could be traced across the intervening æther by stress, so that the tractions on the two sides of each ideal interface are equal and opposite.* As above argued, this view appears to exclude *ab initio* all atomic theories of the general type of vortex atoms, in which the energy of the atom is distributed throughout the medium instead of being concentrated in a nucleus; and this remark seems to go to the root of the question. On the other hand, the position here asserted is that recent dynamical developments have permitted the extension of the principle of Action to systems involving permanent motions, whether obvious or latent, as part of their constitution; that on this wider basis the

* *Cf.* also Hertz on the electro-magnetic equations, § 12, *Wied. Ann.*, 1890. The problem of merely replacing a system of forces by a statical stress is widely indeterminate, and therefore by itself unreal; the actual question is whether any such representation can be coordinated with existing dynamics.

atom may itself involve a state of steady disturbance extending through the medium, instead of being only a local structure acting by push and pull. The possibilities of dynamical explanation are thus enlarged. The most definite type of model yet imagined of the physical interaction of atoms through the æther is, perhaps, that which takes the æther to be a rotationally elastic medium after the manner of MacCullagh and Rankine, and makes the ultimate atom include the nucleus of a permanent rotational strain-configuration, which as a whole may be called an electron. The question how far this is a legitimate and effective model stands by itself, apart from the dynamics which it illustrates; like all representations it can only cover a limited ground. For instance, it cannot claim to include the internal structure of the nucleus of an atom or even of an electron; for purposes of physical theory that problem can be put aside, it may even be treated as inscrutable. All that is needed is a postulate of free mobility of this nucleus through the æther. This is definitely hypothetical, but it is not an unreasonable postulate because a rotational æther has the properties of a perfect fluid medium except where differentially rotational motions are concerned, and so would not react on the motion of any structure moving through it except after the manner of an apparent change of inertia. It thus seems possible to hold that such a model forms an allowable representation of the dynamical activity of the æther, as distinguished from the complete constitution of the material nuclei between which that medium establishes connection.

At any rate, models of this nature have certainly been most helpful in Maxwell's hands toward the effective intuitive grasp of a scheme of relations as a whole, which might have proved too complex for abstract unravelment in detail. When a physical model of concealed dynamical processes has served this kind of purpose, when its content has been explored and estimated, and has become familiar through the introduction of new terms and ideas, then the ladder by which we have ascended may be kicked away, and the scheme of relations which the model embodied can stand forth in severely abstract form. Indeed many of the most fruitful branches of abstract mathematical analysis itself have owed their start in this way to concrete physical conceptions. This gradual transition into abstract statement of physical relations in fact amounts to retaining the essentials of our working models while eliminating the accidental elements involved in them; elements of the latter kind must always be present because otherwise the model would be identical with the thing which it represents, whereas we cannot expect to mentally grasp all aspects of the content of even the simplest phenomena. Yet the abstract standpoint is always attained through the concrete; and for purposes of instruction such models, properly guarded, do not perhaps ever lose their value; they are just as legitimate aids as geometrical diagrams, and they have the same kind of limitations. In Maxwell's words, 'for the sake of persons of these different types scientific truth should be presented in different forms, and should be regarded as equally scientific whether it appear in the robust form and the vivid coloring of a physical illustration, or in the tenuity and paleness of a symbolical expression.' The other side of the picture, the necessary incompleteness of even our legitimate images and modes of representation, comes out in the despairing opinion of Young ('Chromatics,' 1817), at a time when his faith in the undulatory theory of light had been eclipsed by Malus's discovery of the phenomena of polarization by reflection, that this difficulty 'will probably long remain, to mortify the vanity of an ambitious philosophy, completely unresolved by any theory': not many years afterwards the mystery was solved by Fresnel.

This process of removing the intellectual scaffolding by which our knowledge is reached, and preserving only the final formulæ which express the correlations of the directly observable things, may moreover readily be pushed too far. It asserts the conception that the universe is like an enclosed clock that it wound up to go, and that accordingly we can observe that it is going, and can see some of its more superficial movements, but not much of them; that thus, by patient observation and use of analogy, we can compile, in merely tabular form, information as to the manner in which it works and is likely to go on working, at any rate for some time to come; but that any attempt to probe the underlying connection is illusory or illegitimate. As a theoretical precept this is admirable. It minimizes the danger of our ignoring or forgetting the limitations of human faculty, which can only utilize the imperfect representations that the external world impresses on our senses. On the other hand such a reminder has rarely been required by the master minds of modern science, from Descartes and Newton onwards, whatever their theories may have been. Its danger as a dogma lies in its application. Who is to decide without risk of error, what is essential fact and what is intellectual scaffolding? To which class does the atomic theory of matter belong? That is, indeed, one of the intangible things which it is suggested may be thrown overboard, in sorting out and classifying our scientific possessions. Is the mental idea or image, which suggests, and alone can suggest, the experiment that adds to our concrete knowledge, less real than the bare phenomenal uniformity which it has revealed? Is it not, perhaps, more real in that the uniformities might not have been there in the absence of the mind to perceive them?

No time is now left for review of the methods of molecular dynamics. Here our knowledge is entirely confined to steady states of the molecular system: it is purely statical. In ordinary statics and the dynamics of undisturbed steady motions, the form of the energy function is the sufficient basis of the whole subject. This method is extended to thermo-dynamics by making use of the mechanically available energy of Rankine and Kelvin, which is a function of the bodily configuration and chemical constitution and temperature of the system, whose value cannot under any circumstances spontaneously increase, while it will diminish in any operation which is not reversible. In the statics of systems in equilibrium or in steady motion, this method of energy is a particular case of the method of Action; but in its extension to thermal statics it is made to include chemical as well as configurational changes, and a new point appears to arise. Whether we do or do not take it to be possible to trace the application of the principle of Action throughout the process of chemical combination of two molecules, we certainly here postulate that the static case of that principle, which applies to steady systems, can be extended across chemical combinations. The question is suggested whether extension would also be valid to transformations which involve vital processes. This seems to be still considered an open question by the best authorities. If it be decided in the negative a distinction is involved between vital and merely chemical processes.

It is now taken as established that vital activity cannot create energy, at any rate in the long run which is all that can from the nature of the case to be tested. It seems not unreasonable to follow the analogy of chemical actions, and assert that it cannot in the long run increase the mechanical availability of energy—that is, considering the organism as an apparatus for transforming energy without being itself in the long run changed. But we cannot establish a Carnot cycle for a portion of an organism, nor can we do so for a limited period of time; there might be creation of availability accompanied by changes in the organism itself, but compensated by destruction and the inverse changes a long time afterwards. This amounts to asserting that where, as in a vital system or even in a simple molecular combination, we are unable to trace or even assert complete dynamical sequence, exact thermodynamic statements should be mainly confined to the activity of the existing organism as a whole; it may transform inorganic material without change of energy and without gain of availability, although any such statements would be inappropriate and unmeaning as regards the details of the processes that take place inside the organism itself.

In any case it would appear that there is small chance of reducing these questions to direct dynamics; we should rather regard Carnot's principle, which includes the law of uniformity of temperature and is the basis of the whole theory, as a property of statistical type confined to stable or permanent aggregations of matter. Thus no dynamical proof from molecular considerations could be regarded as valid unless it explicitly restricted the argument to permanent systems; yet the conditions of permanency are unknown except in the simpler cases. The only mode of discussion that is yet possible is the method of dynamical statistics of molecules introduced by Maxwell. Now statistics is a method of arrangement rather than of demonstration. Every statistical argument requires to be verified by comparison with the facts, because it is of the essence of this method to take things as fortuitously distributed except in so far as we know the contrary; and we simply may not know essential facts to the contrary. For example, if the interaction of the æther or other cause produces no influence to the contrary, the presumption would be that the kinetic energy acquired by a molecule is, on the average, equally distributed among its various independent modes of motion, whether vibrational or translational. Assuming this type of distribution to be once established in a gaseous system, the dynamics of Boltzmann and Maxwell show that it must be permanent. But its assumption in the first instance is a result rather of the absence than of the presence of knowledge of the circumstances, and can be accepted only so far as it agrees with the facts; our knowledge of the facts of specific heat shows that it must be restricted to modes of motion that are homologous. In the words of Maxwell, when he first discovered in 1860, to his great surprise, that in a system of colliding rigid atoms the energy would always be equally divided between translatory and rotatory motion, it is only necessary to assume, in order to evade this unwelcome conclusion, that 'something essential to the complete statement of the physical theory of molecular encounters must have hitherto escaped us.'

Our survey thus tends to the result, that as regards the simple and uniform phenomena which involve activity of finite regions of the universal æther, theoretical physics can lay claim to constructive functions, and can build up a definite scheme; but in the domain of matter the most that it can do is to accept the existence of such permanent molecular systems as present themselves to our notice, and fit together an outline plan of the more general and universal features in their activity. Our well-founded belief in the rationality of natural processes asserts the possibility of this, while admitting that the intimate details of atomic constitution are beyond our scrutiny and provide plenty of room for processes that transcend finite dynamical correlation.

Joseph Larmor.

INLAND BIOLOGICAL LABORATORIES.

The following informal notes have been received concerning the season's work in various summer laboratories and experiment stations:

Of the research work carried out on the Great Lakes under the auspices of the United States Fish Commission, Professor Reighard says: The work has been purely research work and it was understood from the start that it should be of a fundamental scientific character rather than directed toward the immediate solution of questions of supposed practical importance.

The funds available have not permitted of carrying on the work for more than two months of each summer. During the summers of 1898 and 1899 it was carried on chiefly at Put in Bay, Ohio, (an island in the western end of Lake Erie, at which there is a hatchery of the Commission). By removing the internal fittings of the hatchery it was temporarily converted into a laboratory for each summer's use. This laboratory has been in every way amply equipped. There is gas and water, a small steamer and a supply of other boats. It is intended that work should begin on the first of July, but owing to delay in appropriation bills and to other causes it may happen, as it did this year, that no authorization for the commencement of the work can be issued until the end of June or even the early part of July. Supplies must then be ordered, arrangements made with workers and the hatchery converted into a laboratory. The difficulty involved in undertaking to do this after the first of July for work which is to continue only two months, led this year to the trial of a different plan. Instead of opening the Put in Bay laboratory an effort is being made to carry on the work by means of individual investigators or small parties working independently. It is hoped that work carried on in this way can be continued over a longer period, even during a part of the college year.

The investigations carried on at the laboratory (and elsewhere during the present summer) are as follows:

BOTANICAL WORK.

1. *The Algæ of Lake Erie.*—Dr. Julia W. Snow has been engaged during each of the three seasons and is now engaged in the determination of the algæ of the Lake and in working out their life histories by means of cultures. As many of them assume different forms under different conditions, it is necessary to cultivate them and no final identifications are possible until the life history of each is known. This is of course a labor of years and involves a consideration of the relation of the various algæ groups to the nutritive substances contained in the water, that is, it leads into bio-chemistry. It is expected that results already obtained will be made ready for publication during the coming year.

2. *The larger Aquatic Plants.*—During the first season Mr. A. J. Pieters of the Department of Agriculture at Washington undertook a study of the larger aquatic plants with the purpose of determining whether they are wholly dependent on the water for nutrition or partly on the soil. Mr. Pieters' results are now in press. He did not get much further than a determination of the various soils present on the Lake bottom and the relation of the plants to them. During the second season and during the present season Mr. R. H. Pond, an assistant in Botany at the University, has car-

ried on the work by experimental methods, Mr. Pieters' duties at Washington not permitting him to continue it. Mr. Pond expects to conclude his work by the end of the next academic year.

ZOOLOGICAL WORK.

1. *Collections.*—During the first two seasons extensive collections were made of the invertebrate fauna of the Lake, also collections of the contents of fish stomachs and of the parasites of the aquatic vertebrates. During the past summer a camping party was sent about the shore of the Lake for the purpose of making these collections. Some of the material has been distributed to specialists, but no reports have as yet been received. Pending this, collecting has been discontinued.

2. *Plankton Work.*—This has been carried on by myself with the cooperation of Dr. H. B. Ward of the University of Nebraska. Apparatus has been devised for measuring the actual flow of water through the plankton net. This apparatus is now being rated at the hydraulic laboratory of the University of Ohio, at Columbus. When this work is finished the apparatus will be used in the Lake. It is hoped by this apparatus to settle the question of the actual availability of plankton nets for quantitative work, to find the actual volume of water strained by them and to what extent they become clogged with use.

The Illinois State Laboratory of Natural History has a biological station under the direction of Professor S. A. Forbes, which is not a summer laboratory merely, but is established for continuous investigation of the aquatic life of the State, and is in active operation throughout the year. It is an institution for research and not for instruction, the work being done by a Superintendent and a paid staff.

At present two lines of work are in progress. (1) Systematic study of the ichthyology of the Station field and of other parts of the State reached by excursions, together with the painting of a series of illustrations of the fishes of the State made in the field from the living specimens. (2) An analysis and statement of the results of five years of plankton work done on the Illinois river, at Havana and Meredosia. The work on ichthyology will result in the publication of a State report covering the whole subject for the State of Illinois, a large part of the manuscript for which has already been prepared; and that on the plankton will be ready for publication January 1st, in the form of an independent Bulletin article.

In the absence of Professor C. H. Eigenmann, the Indiana University Biological Station was this summer under the direction of Dr. Robert E. Lyons. The research work being done was as follows: Ed. Showers, 'The Vertical and Horizontal (qualitative and quantitative) Distribution of Bacteria in the Lake'; Mr. Hunt, 'The distribution of Bacteria in the Air'; Mr. Rush, 'The Rôle of the Horseflies and Mosquitoes in carrying Infectious Diseases'; Dr. Baldwin, 'On an Intro-utero cure for Hog Cholera'; Dr. Howe, 'On the Plankton of the Lake.' Mr. Clark and Mr. Ek are completing their floral survey of the Lake; Mr. Ramsey is continuing the faunal survey; Mr. Moenkhaus is conducting the survey work of the Lake.

The entomologic field station of the New York State Museum is a station for the study of the biology of aquatic insects. Professor James G. Needham, of Lake Forest University, is in charge. Investigation is its sole object at present: no courses of study are offered. The work is mainly done by Professor Needham and Mr. Cornelius Betten, assistant in biology in Lake Forest University, with the occasional assistance of visiting specialists, to whom the facilities of the Station are offered. The location is admirably suited to the purposes in view. Near at hand there is a very great variety of aquatic situations and a rich and varied aquatic fauna. The aquatic insects most abundantly represented are caddice flies, dragon flies, may flies and aquatic Diptera: much work has already been done here on the life histories, habits and ecology of these.

The Station for the present season finds quarters in the Adirondack Fish Hatchery building at Saranac Inn, where an abundance of running water renders possible the rearing of the insects which live in the limpid streams outside. The initial equipment of the station was excellent, and the work has been prosecuted under favorable circumstances. While no instruction is offered here, an effort will be made to report the result of the work in such form as to be available for the use of teachers of natural science generally.

The houseboat 'Megalops' of the Zoological Survey of Minnesota has just been closed and put into winter quarters near the southern boundary of the State. This houseboat was built at Mankato a year ago last spring, for the purpose of investigating the fauna of the Mississippi and Minnesota rivers from Mankato to the southern boundary of the State. Special attention was given to the fishes. The reptiles, amphibia and mollusks also received considerable attention. The smaller forms are to be studied more carefully at stations to be established where the experience of the past two seasons has found the conditions to be most favorable. It is the intention of the Director of the Survey, Professor Nachtrieb, to use the houseboat as headquarters for these investigations near the head of Lake Pepin. Thus far the houseboat has proved to be a most satisfactory and economical institution for such work. The results of the investigations will be published in the Zoological Series of the Reports of the Geological and Natural History Survey of Minnesota.

Some very excellent and satisfactory work has also been done on the birds of Minnesota during the past season. This work is under the immediate direction of Dr. Thomas S. Roberts. The work on the fishes is under the immediate direction of Professor U. O. Cox, of Mankato.

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*THE COLORADO POTATO BEETLE.**

THE Colorado potato beetle *Leptinotarca decem-lineata* Say, is one of several closely allied forms that have spread over North America until one or more is found in almost every part of the continent east of the Rocky Mountains, and south of 50 degrees north.

The parent form *L. undecem-lineata*, seems to have originated in the northern part of South America. When the great northward migration came following the retreat of the continental glacier, it is probable that this form also went north, and in its journey encountered the diversified Mexican region, where it split into several racial varieties, each characteristic of a certain climatic area. As the advancing hordes spread northward, three well marked climatic belts were encountered, the Pacific Coast belt of Mexico, and the Mexican table land, and the low Gulf Coast area.

From the Pacific coast strip not much evidence is obtainable as to the presence of these beetles, or the changes produced upon them. On the table-land, however, the form was diminished in size and the pigmented areas are broken up into smaller spots. This form which is called *L. multilineata* grades into *L. undecem-lineata* on the south, and to the northern part of the Mexican plateau passes imperceptibly into *L.*

* Abstract of a paper presented before the Section of Zoology of the American Association.

decem-lineata, the latter form extending northward along the eastern slope of the western highlands, and west of the arid region, spread as far north as the Canadian boundary, and perhaps even farther.

The low humid Gulf coast area also produced a characteristic form, *L. juncta*, which can be traced into the parent form in the lower part of the Mexican region, and which spread up the Mississippi valley into southern Illinois, and along the Gulf, and up the Atlantic coast to Maryland.

Such was the distribution of these beetles until the middle of the nineteenth century. About 1840 the potato began to be cultivated in the cañons of Colorado, and *L. decem-lineata* soon left its old food plant, *Solanum rostratum*, for the new *S. tuberosum*, causing, no doubt a rapid increase in the number of the species. In 1849–50 began the rush to California from Council Bluffs west along the Platte river. There are several accounts extant of the sale of potatoes to emigrants by thrifty Irishmen at Omaha and Council Bluffs, and judging from the haste and carelessness of the emigrants there can be no doubt that potatoes were lost or thrown away along the route. The valley being fairly fertile and moist, these potatoes grew until there was a more or less continuous line of potato plants from Council Bluffs along the Platte river to the cañons of the Colorado region. Along this route *L. decem-lineata* moved eastward so that in 1859, ten years after the '49 rush to California, the beetle is reported as injurious to crops at a point just east of the arid belt and about on the 98th meridian. During the next twenty years it reached the Atlantic coast and covered the entire country between latitudes 37° and 47° north.

Connected with the advance of this form there are several features of general interest. The beetle is double-brooded over the whole area, but it is only the second, or August brood, that flies to any great extent, and, consequently, has pushed into the hitherto unoccupied territory. However, the new areas covered have not been overrun by the unaided flying of the beetles eastward. If no outside agent were at work the beetles would fly west as often as east, so that alone no great advance would be made. It is to be noted that the beetle is not a strong flyer, that it is unable to advance successfully against the wind, and that the direction of its flight is, therefore, controlled largely by the wind. In August and September there are established certain well defiued wind tracts, and it is along these that the beetle has advanced with the greatest rapidity, the advance being directly proportional to the wind velocity in any region for a given year. The most rapid advance has been in the track of the prevailing westerlies along the lakes and down the St. Lawrence valley. This point is proved by contrasting the northern advance with the extremely slow advance southward, the latter being due in part to the temperature and moisture conditions, but largely to the variable winds of the southern part of the United States in late summer.

The entire advance of this form east of the arid belt has been independent of lines of travel, there being no evidence of any considerable transportation by human agencies.

At the present time the beetle is found throughout all that portion of North America which lies east of the Rocky Mountains and between latitudes 32° and 55° north. It has been found as far north as 65°, but to my knowledge has not gained a foothold in Labrador or Newfoundland.

It is interesting to note that as *L. decem-lineata* has advanced *L. juncta* has retreated before it. Formerly *juncta* was abundant in southern Illinois, and in Delaware, Maryland and New Jersey, but now it has retreated to the Carolinas on the Atlantic coast and to lower Mississippi on the south.

In a relatively short time this insect has overspread a large area and has encountered various climatic conditions and the question at once arises as to whether these conditions have yet produced any appreciable effects. If, using the Colorado specimens as a type, we compare these quantitatively with specimens from other parts of the United States, the presence of several already well-marked varieties is shown. These are correlated closely with the climatic conditions of the several areas for the months of June, July and August. Without going into details at the present time, I shall simply mention the areas in which these incipient varieties are forming. In the northwest is found the well-marked 'Dakota type' which has spread over the Dakotas, Manitoba and parts of Wisconsin and Nebraska. In the southwest is the 'Texas type,' found in northwest Texas, Arkansas, Kansas and New Mexico. In the region about the Great Lakes there is the 'Lake type,' and in the northeast is found the 'New England type,' which covers New England and Nova Scotia, while in the southeast there are the 'Atlantic coast type,' and the 'Southern Appalachian type.'

These types are not as yet far removed from one another, nor are they easily seen on inspection. However, measurements show changes in dimensions and in coloration in the several areas, so that there can be no doubt that there are slowly forming several races of the beetle in different parts of the United States and Canada as a direct result of the diversity of environment. As 45,000 specimens from different parts of the United States have been studied the error from too few individuals is obliterated.

W. L. Tower.

THE EIGHTH INTERNATIONAL GEOLOGICAL CONGRESS AT PARIS.

The Eighth Congress of Geologists assembled in the *Palais des Congrès*, Thursday, August 16th, at 4 p. m. M. Karpinsky, retiring president, gave the opening address and was followed by the president, M. Albert Gaudry, in a cordial address of welcome. The geologists of the continent were well represented and appeared in full dress with all their medals and decorations. England and America were comparatively inconspicuous both in numbers and in attire.

The registration was 288 upon the second day. All the most distinguished geologists of Europe were in attendance. England sent an exceptionally small number. Among the Americans present were Messrs. Stevenson, Hague, Osborn, Ward, Willis, White, Cross, Scott, Todd, Kunz, Choquette, Adams, Matthew, Ries, Willmott, Rice; the three first named were chosen as vice-presidents. M. Barrois closed the first session with reports upon the program and upon the geological excursions which were arranged in a most admirable manner before, during and after the congress. On the same evening a delightful reception was given by the Geological Society of France in their new quarters, Rue Danton 8. On Friday morning the section of geology and tectonics, presided over by M. Geikie, held its first session, with communications by Geikie, Chamberlin, Joly, Lapparent, Munier-Chalmas and Roland. In the afternoon the section of mineralogy and petrography listened to a report of the petrographical commission by M. Lacroix. In this connection may be mentioned the fact that during the Congress plans for an international petrographical journal were successfully matured.

On Saturday at ten o'clock the Section of Applied Geology met under the direction of M. Schmeisser, and at one o'clock M. Zittel presided over the first session of the Stratigraphy and Paleontology. The important business of this session was the discussion of the final report of the stratigraphical commission which was presented by M. Zittel in the absence of its chief advocate, M. Renevier; difference of opinion chiefly concerned the proposed substitution of the terms Paleozoic, Mesozoic and Cenozoic for Primary, Secondary and Tertiary; when this proposal was practically withdrawn by M. Bertrand the report was adopted. The Congress adjourned to a reception by M. and Mme. Gaudry in the new gallery of Paleontology in the Jardin des Plantes. The installation of fossils and vertebrates in this gallery and the comparative anatomical museum on the lower floor rearranged by M. Filhoz were greatly admired. Sunday, Monday, Wednesday, Friday and Sunday following were devoted to very attractive excursions to the classic horizons in the neighborhood of Paris and to the scientific features of the Exposition, while four more days were assigned to the work of the Sections, including the closing session of Monday, August 27th.

The papers were successively brought together in groups as follows: general geology, petroleum-bearing rocks and paleozoic succession, geology of Syria, Africa and Madagascar, petrography and vulcanism, glacial phenomena and report of international commission on glaciers, report on nomenclature and the geological chart of Europe, geology of North and South America (communications by Osborn, Scott, Matthew and Walcott). Among matters of detail the following deserve mention: the award of the 'Leonide Spendiaroff international prize' to M. Karpinsky, who insisted upon transferring the money award to some young French geologist; the announcement by M. Keilhac of a new geological review, the *Geologisches Centralblatt;* the selection of Vienna as the meeting place for the ninth congress.

The unbounded hospitality of the government, of the Exposition authorities and of the members resident in Paris was greatly appreciated and enjoyed. The President of the Republic invited all the *Congressistes* to a charming afternoon reception and open air theatricals in the garden of the Elysée palace. There was also a liberal distribution of seats and boxes in the national theatres. M. and Mme. Gaudry and Prince Roland Bonaparte gave two evening receptions. On Saturday, August 25th, an elaborate banquet was given by the French Geologists in the new *Hôtel du Palais d'Orsay.* The excursionists also were indebted for liberal reductions in fare made by the French railroads. Socially the Congress was a great success, the receptions as well as the intervals between the sessions affording abundant opportunities for personal intercourse, and it is well recognized that this, rather than the presentation of long and serious papers, is the chief end of a congress. At the same time it was felt by many present that several of the papers presented were not of a high order or general character and should not have been admitted at all, and that the time arranged for discussion was insufficient. The scientific spirit was naturally somewhat disturbed by the proximity of the Exposition and the *Salle des Congrès* itself was not well suited for the meetings in point of acoustics or apparatus. But for these features the French geologists were not responsible and, with one or two minor exceptions, the arrangements over which they had complete control were excellent. This is especially true of the excursions which were admirably prearranged and conducted; the *Guide Géologique de France*, prepared for the twenty great and many lesser excursions, is really a voluminous treatise and resumé of the most recent geological researches in France, attractively illustrated by 372 figures and 25 plates; it sets a new standard for future congresses.

All who attended the Congress felt more than repaid for the journey to Paris and deeply indebted to the genial President, Professor Albert Gaudry, to the indefatigable and much beloved Secretary, Professor Charles Barrois, and to his associates, Messrs. Thévenin, Von Arthaber and Zimmermann.

H. F. O.

SCIENTIFIC BOOKS.

Introduction to Zoology. By Charles Benedict Davenport and Gertrude Crotty Davenport. New York, The Macmillan Co. 1900. Pp. xii + 412; 311 illustrations. Price, $1.10.

The purpose of this new text-book, as indicated by its secondary title, is that of 'a guide to the study of animals for the use of secondary schools.' Unlike most of its predecessors among zoological books for secondary schools its title is not misleading, for the book is sent forth not as an 'elementary zoology' but as an *introduction* to the study of animals. It does not pretend to be a treatise on 'zoology' from the varied aspects of comparative anatomy, embryology, and physiology, but rather it attempts a presentation of facts which may well pave the way for advanced study of the special sub-sciences of zoology. But in addition to writing an introduction for students who may go deeper into zoological studies, the authors have recognized the important fact that 'the vast majority of secondary students, are not to be zoologists, but rather men of affairs.' Although this view has been gaining recognition in recent years, this is the first text-book which seems to have been planned with consideration for the needs of the 'vast majority' who are limited to a short elementary course in zoology.

Contrasted with the elementary books on zoology which have appeared during the last decade, the plan of this book is decidedly new; for it places no emphasis upon comparative anatomy, which has strongly characterized recent zoological teaching in most secondary schools. There is no description of internal structure of animals, and consequently no discussion of fundamental physiological processes. The book deals with common animals, and their habits, homes, their life histories, and their systematic, economical and ecological relations. In short, the book is a *modern* Natural History full of the spirit and the charm which characterized the old-time books on that subject.

As a text-book the 'Introduction to Zoology' is intended to accompany the well-known outline of laboratory study in zoology which Professor Davenport prepared several years ago, and which was published as an 'Outline of Requirements in Zoology,' Lawrence Scientific School, Harvard University. A revised reprint of this outline forms an appendix to the book. The order of treatment in the text follows that of the outline for laboratory work, beginning with insects and following with other arthropods, worms, mollusks, echinoderms, cœlenterates, protozoa, and the vertebrates.

Considerable attention is given to classification. Twenty chapters have appendices with keys for identification of common families and orders. Both common and scientific names of animals are freely used in the text, and foot-notes give the meaning and derivation of the technical names.

The book is liberally illustrated both by figures from well-known works and by numerous new photographs of the natural objects. With regard to the photographs it must be regretted that many are imperfect and do not well illustrate. One feels convinced that good outline drawings would in many cases have been more instructive, particularly in the case of small animals like insects. However, many of the photographs are excellent and add a charm to the book.

On the whole the book is written in an entertaining style, and can scarcely fail to arouse interest concerning our common animals. The authors have well presented the natural history aspect of zoology. Teachers who read the book will probably agree that for liberal secondary education no other phase of zoology would be more important, but many readers will doubt the wisdom of omitting from secondary education all reference to the essential facts concerning the internal structure and the fundamental physiological processes of animals.

The book will surely find a place in secondary schools whose teachers recognize that most of their pupils are studying zoology for use in everyday life and not as preparation for advanced study in college. Moreover, college officers in charge of admission requirements will probably give more favor to such a course in elementary zoology than they have accorded the purely morphological study which is now so much in vogue in secondary schools.

MAURICE A. BIGELOW.

TEACHERS COLLEGE, COLUMBIA UNIVERSITY.

Oysters and Disease. An account of Certain Observations upon the Normal and Pathological Histology and Bacteriology of the Oyster and other Shell-fish. By W. A. HERDMAN, D.Sc., F.R.S., and RUBERT BOYCE, M.B., London. George Philip and Son. 1899. Lancashire Sea-fisheries Memoir No. 1.

In this thin volume Professors Herdman and Boyce, record the results of an investigation extending over a period of three years and, although they have not actually established a connection between oysters and disease, they have produced the most important contribution which has yet appeared upon the subject, which is one of considerable scientific and unusual popular interest.

The disputed question as to the cause of green oysters has been re-examined, with the result that several forms of greenness have been recognized and studied. But little is added to our knowledge of the well-known oysters of Marennes, the authors being in practical accord with most previous investigators, but concerning the green oysters of Falmouth and certain green American oysters laid down in the vicinity of Liverpool they reach results divergent from the views held by previous workers and more in accord with popular beliefs.

Copper in minute quantities is normally present in all oysters, but in the green Falmouths and Liverpool Americans it is found in unusual amounts. In the greenest of the American oysters as compared with the whitest, the proportion is 3.75 : 1, calculated per oyster, and 3.63 : 1, calculated on the ash, and a careful study of the distribution of the copper by chemical and histo-chemical methods demonstrates that it is the cause of the greenness.

Some years ago Dr. Ryder, as noted by the authors, studied a case of leucocytosis in American oysters, although he did not determine the presence of copper nor appreciate the true cause of the greenness. The reviewer has examined during recent years, a great many green oysters, but in no case has the greenness been in the leucocytes of the blood of the heart and the sinuses and tissues of the mantle, as described by Ryder and the present authors, nor in those which were tested, has the copper been present in abnormal quantities or unusual distribution. The specimens rather resembled the poor but harmless Dutch oysters described by Herdman and Boyce, and it would appear that we have in America, as in Europe, several kinds of green oysters, that in which the color is due to copper being comparatively rare.

The connection of oysters with the transmission of infectious diseases, especially typhoid and enteric fevers, is carefully considered. Bacilli of the colon group are frequently found in oysters sold in towns, but there is no evidence that they occur in those living in pure sea-water. The experiments show that pure sea-water is inimical to the growth of typhoid bacilli and that they do not multiply either in the alimentary tract nor in the tissues of the living oyster. *B. typhosus* was not found in any of the oysters obtained from dealers or directly from the sea, but from inoculated specimens the bacilli were obtained up to the tenth day, although the results indicate that they perish during passage through the intestines.

Oysters and other mollusca obtained from dealers frequently contain a bacillus possessing the characters of Klein's *B. enteritidis sporogenes*, presumptively resulting from sewage contamination, but it was found that the infected oysters could be cleansed by washing in clean running sea-water. It is evident, therefore, that by changing oysters from an infected bed to one where the surroundings are pure they may be purged of their dangerous qualities. The authors urge, in conclusion, that, by legislative action and cooperation among growers, steps be taken to prevent sewage contamination of the oyster beds from which the markets are supplied.

Several facts are added to our knowledge of the minor anatomy of the oyster, especially interesting being the demonstrated change in the primitive retractor pedis muscle whereby it becomes a dilator oris.

The paper is well illustrated.

H. F. Moore.

Washington, August 25, 1900.

Anatomie et physiologie végétale. For the use of students of natural science in universities and agricultural schools, etc. By Professor Er. Belzung. Ancienne Librairie, Germer Baillière et Cie. Paris, 1900. 1699 Figs. 8vo. Pp. iii + 1320.

Professor Belzung is the author of text-books on geology, zoology, animal physiology, and animal paleontology, in addition to two or three botanical works besides the subject of this review. Such breadth of authorship undoubtedly relieves him from any taint of narrow specialism. This experience secures for the book in question, however, no new points of view, since it is a purely formal presentation of the better known facts in botany compiled after the manner of an encyclopedia. Perhaps the freshest portion of the book is that taken up with the subject of fermentation, which is given a treatment not usually accorded this phase of botany in general texts. The final section of the work consists of the 'Conclusions' and is devoted to the general characters of protoplasm and plants usually given in the introductory chapters of such texts.

The book leads chiefly to the examination room, and only the most determined enthusiasm could carry through its use a genuine interest in the study of plants.

D. T. MacDougal.

Report of Competitive Tests of Street Car Brakes. By the Board of Railroad Commissioners of the State of New York. 1899. Albany, Brandon Printing Co., Department Printer, 1900. 8vo. Pp. 60; 67 sheets of diagrams.

The report of the electrical expert, Mr. C. R. Barnes, April 4, 1900, details the origin and progress of the work of the N. Y. State Board of R. R. Commissioners, conducted to ascertain the practicability of insuring greater safety in the operation of street cars moved by cable and by the electric current, comparing the newer forms of brake with the older. It is stated that 295 people have been killed and 1599 injured by the electric railways of the State of New York in three years, as shown by the records of the Board. These figures indicate a rapid increase in this form of mortality, due to rising weights of cars and increasing speeds. Cars are now in use weighing 23 tons and speeds exceeding 50 miles an hour have been attained on suburban lines.

In preparing for these trials Messrs. Barnes and Pierson, the electrical engineer of the Metropolitan R'y Co., designed and constructed an automatic recording apparatus for measuring lengths of run under action of the brake. The apparatus was calibrated on 275 feet of track assigned for the purpose by the railway company and the essential observations and data were derived by use of this instrument; the work being performed in New York on the Lenox Avenue line, in the half-mile between 135th and 146th streets. Sixteen brakes—4 air-brakes, 4 electric, 3 hand-power, 2 friction and 2 'track-and-wheel' brakes—were tried.

The reliability of the air-brake is reported to be thoroughly established and a number of them have come into use. But one electric brake, that of the General Electric Co., is in use to any extent. New forms of the older type, the hand-power brake, were tested. They act directly upon the wheels, as usual. The so-called 'friction-brake' is a friction device on the axle, usually disks rotating with the axle and engaging stationary disks, the two sets arranged to be forced strongly against each other, when in action, by means of ingenious mechanisms. The 'track-and-wheel brake' acts on the tracks as well as the wheel. Photographic reproductions of the autographic diagrams obtained from each brake are published, with appended tables exhibiting results numerically.

The usual experiences in such work with dilatory exhibitors, incomplete outfits and occasional miscarriage of the plans of the Board was observed in these trials; but a large amount of new data in a novel field of research was obtained. The results were classified and an order of standing was determined under the four heads : reliability and simplicity ; liability to act when not required ; ease of operation ; cost of equipment and maintenance.

The most remarkably wide range of prices is reported—$30 to $585, averaging about $200. Eleven of the list tested are authorized for use, and the Board determined that the common form of brake now in use should be replaced by one or another of these, or equally efficient, brakes.

President Vreeland, of the Metropolitan Co., his directors and the executive officers seem to have taken much trouble and to have met most of the expenses of these important pioneer investigations, and his electrical engineer, the master mechanic and the superintendents lent essential aid in the work.

The report can be had by applying to the Board at Albany.

The data may be summarized thus : At 8 miles an hour, a stop was made in from 3 to 8 seconds ; at 12 miles in 5 to 9 seconds ; at 15 miles, in 6 to 10 seconds ; at 16 miles, in 6 to 11 seconds, without sand, and 6½ to 9½ with sand. The distances run ranged from 35 to 66 feet at 8 miles, 58 to 111 at 12 miles, 72 to 203 at 16 miles ; averaging for all speeds, from 58 to 133 feet.

A conventional system of checking for 'skidding' wheels was adopted.

All in all, the work must be accepted as an earnest and faithful endeavor to effect, for the first time, a solution of an important problem—one which concerns all railway managements and all travellers on electric street cars very seriously. The report has been criticised as failing to give data relating to dimensions of parts, uncertainty regarding the comparability of brakes differently handled by their exhibitors, and regarding the automatic records. An examination of the apparatus employed, however, shows that the distances traversed were measured by a mechanism positively driven and which, therefore, gave reliable comparison of distances traversed, which measures are the sole basis of all comparisons and are evidently substantially correct. The technical journals generally approve the report as giving valuable and helpful information. Undoubtedly, later investigations will afford opportunities for improvements which this, as all pioneer efforts, indicates to be desirable notwithstanding its evident and admitted defects in time-measurement, the report must be accepted as important. Variations of the time-scale do not affect its conclusions. It is to be hoped that the work will be continued and perfected.

R. H. Thurston.

Lehrbuch der Photochromie von Wilhelm Zenker; neu herausgegeben. Von Professor Dr. B. Schwalbe. Braunschweig, Friedrich Vieweg & Sohn.

This is a republication of a work which appeared iu 1868, to which has been added a biographical sketch, and a résumé of recent work along similar lines.

It will doubtless surprise the general reader to find that partially successful experiments in photochromy, or the *direct* reproduction of color by photography, were made over a quarter of a century before the announcement of Daguerre's discovery in 1839. As early as 1810 Seebeck obtained colored impressions of the solar spectrum on paper coated with chloride of silver, but the matter attracted but little attention and was soon forgotten.

In 1841 the property which this substance possessed of assuming a color somewhat similar to the hue of the light falling upon it was rediscovered by Herschel, but the possible great importance of the subject does not appear to have been realized until Becquerel, stimulated by Daguerre's discovery, took up the work, and by a laborious series of investigations determined the conditions most suitable for a faithful reproduction of the colors of the original.

Up to the time of the appearance of Zenker's work the almost universal opinion seems to have been that colored compounds of silver (oxidation and reduction products) were formed by the action of the light. Zenker, however, offered a most ingenious physical explanation, as opposed to the chemical theory. He explained the colors as due to the interference of light reflected from thin laminæ of metallic silver, laid down in sheets half a wave length apart, by the action of stationary light waves, resulting from the interference of the direct wave train with the train reflected from the back surface of the film. In other words, the colors of the photochromes were similar to the colors of the soap-bubble. This is precisely the principle since made use of by Lippman in his beautiful process.

Zenker's book opens with a short elementary account of the nature of light, of no especial interest. Following this comes a very complete account of the work of Seebeck, Becquerel, Poitevin and others. His account of the claims of Hill, the American photographer, are interesting, final judgment of the case being left to the reader.

Full details are given in most cases of the method of preparing the plates, and the reader will find himself strongly tempted to repeat some of these early experiments.

The third portion of the book treats of the theory of photochromy. The colors of the photochromes had been explained in various ways. Some held that colored oxidation and reduction products were formed while others assumed that the chemical action of the light occurring at the surface, formed a film of varying thickness which showed color precisely like the film of a soap bubble. Zenker effectually demolishes this theory by showing that prolonged exposure, by increasing the thickness of the film, should change the color, which is not the case.

He then advances his own beautiful theory, not abandoning the soap film idea, but presenting it in a wholly new light. He conceives the light waves as penetrating the film and suffering reflection at the back surface. The reflected waves interfere with the oncoming waves forming a stationary system, the ether within the film vibrating in nodes, like the string of a musical instrument when sounding a harmonic. He shows us that there will be planes of vibration within the film parallel to the reflecting surface situated half a wave-length apart. In other words the distance between the planes of maximum vibration will depend on the wave-length or color of the light. If the silver is reduced in these planes and not at the nodes (when there is no vibration) we shall have reflecting laminæ formed, which will act like the upper and lower surface of a soap film and show interference colors. The light most copiously reflected under these conditions will be of a color identical with that of the light which formed the laminæ. He describes a number of experiments confirming his theory, but pushes it too far in attempting to explain the color of ordinary objects and the perception of color by the eye in this way.

His book is on the whole a most excellent résumé of the work done up to the time of its publication.

The appendix, in which the further development of the subject is treated by E. Tonn, deals chiefly with matters of theoretical interest. The work of Wiener and Lippmann is discussed in connection with the theory of the reproduction of mixed colors. As a matter of fact there have been very few or no developments since the time of Zenker, except along the lines indicated by Lippmann, and as no details of this process are given, the appendix is likely to be of interest to the physicist rather than to the photographer.

R. W. Wood.

BOOKS RECEIVED.

Grundlinien der anorganischen Chemie. Wilhelm Ostwald. Leipzig, W. Engelmann. 1900. Pp. xix + 795. 18 Marks.

Der Gesang der Vögel. Valentin Häcker. Jena, Gustav Fischer. 1900. Pp. vii + 102. 3 Marks.

Symons's British Rainfall, 1899. Compiled by H. Sowerby Wallis. London, Edward Stanford. 1900. Pp. 251. 10s.

Foundations of Knowledge. Alexander Thomas Ormond. London and New York, The Macmillan Co. 1900. Pp. xxvii + 528.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

At the meeting on May 21st, Dr. A. A. Julien presided and about twenty persons were present. Two papers on the rocks of Mexico were presented. The first was by Mr. G. I. Finlay, entitled 'A New Occurrence of Nephaline Syenite and associated Dikes in the State of Tamaulipas, Mexico, with a review of the distribution of these rocks in North America.' The second paper was a 'Contribution to the

Geology of Part of Sonora, Mexico,' by Mr. B. F. Hill. Both gentlemen are post-graduate students of Columbia University.

The rocks described by Mr. Finlay were sent by Mr. E. D. Self to Professor J. F. Kemp. The nephaline syenite is a very light-colored rock, containing, besides abundant nephaline and an orthoclase, small patches of dark-colored silicates. Under the microscope these are seen to be ægerine augite intergrown with hornblende, and accompanied by magnetite and apatite. Titanite is abundant, with the faces (1–2–3) well developed, and some zircon occurs. The tinguaite associated with this syenite is a holocrystalline porphyritic dike rock, with large phenocrysts of orthoclase, twinned on the Carlsbad law, tabular in habit, parallel to the clinopinacoid. The ground mass which gives the rock an even, dark green color, consists of a felt of tiny blades of ægerine and orthoclase. The ægerines are at times grouped together in bundles around small patches of biotite.

Mr. Finlay then briefly discussed the distribution of similar rocks in the various portions of the United States, and exhibited a very instructive series of comparative charts of the chemical composition of the rocks examined and those of allied groups, the charts being constructed on the principles of the graphic method devised by Professor Hobbs, as worked out by Mr. Finlay.

The second paper, that of Mr. Hill, also treated of Mexican rocks, and the same geographical maps were employed to illustrate both papers. Little has been written about the coal-bearing rocks and their associated eruptives in the state of Senora, Mexico. The work done by Professor Dumble and his associates has thrown considerable light on some of the problems.

In the district investigated are representatives of nearly all the formations from the Archæan granites to the Quarternary sands and gravels. The most important division, however, is the Triassic. The slates, sandstones, quartzites, etc., with coal seams, make up the lower or Bananca division of the Triassic, while an immense series of associated eruptives, including andesites, dacites, tuffs, andesitic, conglomerates, etc., is considered the upper division. To the series of eruptives the name of Lista Blanca has been given. The Lista Blanca has hitherto been considered post-Cretaceous.

In addition to the pre-Cretaceous eruptives, there are numerous intrusives and flows of diorites, rhyolate, and basalt, and in one instance, trachite. It is probable that these are mostly of Tertiary age. The diorites exert a very noticeable effect on the formation of the ore bodies of the region.

Specimens of all the eruptives were brought to New York and studied by Mr. Hill, in thin section, under the microscope. A series of chemical analyses of the type rocks was made and a very clear relation established between the magmas of the different flows. The remainder of the paper dealt with details on the petrographic characteristics of the rocks.

Both papers were discussed by Professor Stevenson, Professor Kemp, Dr. Julien and Dr. White.

Theodore G. White,
Secretary of Section.

DISCUSSION AND CORRESPONDENCE.

MR. TESLA AND THE UNIVERSE—HUMAN ENERGY AND HOW TO INCREASE IT—HIS PHILOSOPHIZING QUESTIONED.

Mr. Nikola Tesla has written a long article in the *Century Magazine* for June with the title 'The problem of increasing human energy, with special reference to harnessing the sun's energy.' The paper is profusely illustrated with impressive cuts of electrical experiments which, at first sight, seem convincing. Most readers of the *Century* looked at the striking cuts and glanced at some of the head lines of the article such as 'Development of New Principle'; 'Production of Immense Electrical Movements'; 'The Earth responds to Man'; Interplanetary Communication now probable,' and accepted the headlines on the testimony of the cuts; or else took it frankly for granted that so long an article must certainly prove a great deal.

The present writer has lately gone over the text of the article, pen in hand, and herewith presents a small portion of his notes. They seem to him to show that the article in question is composed, essentially, of three different kinds of writing. The first kind describes Mr. Tesla's experiments in electricity and shows what he has already accomplished. This work is, no doubt, important. Its value will be appraised by experts. The present writer has no claim to be considered an electrical expert and does not attempt to give an estimate of the achievements referred to. The second describes what Mr. Tesla expects to accomplish in the future. His prophecies are so sanguine, in many cases, that even a general reader may presume to compare them with the comparatively small things already accomplished and to point out how very unlikely it is that any great part of his expectations will be realized within any reasonable future—within Mr. Tesla's own lifetime, for example.

The third element of this article consists of philosophical arguments about things in general—about human life—what it is—the future of the solar system—the solidarity of the human race—the Christian religion—vegetable food—theoretical dynamics—athletics in colleges—drinking water—ozone—education of women—ice—fertilizers—insanity—warfare—flying machines—iron manufacture—aluminium—liquid air—self acting engines—the inhabitants of Mars—etc., etc., etc.

Now these and other matters are interesting in themselves. We are all anxious to obtain new light upon them. We are all more or less competent to judge the conclusions of other people regarding them. It is not too much to say that this portion of Mr. Tesla's paper is in the main so trivial, so superficial, so obviously weak, as to throw doubt upon the whole essay. Many of the subjects treated are the oldest problems of the human race. They have been discussed by every philosopher since Aristotle. It is fairly astonishing to see Mr. Tesla's reasonings in print at this day. They compare with the logic of giants like Spinoza, Kant, Lord Kelvin, Herbert Spencer, and the rest as a baby's prattle to the 'Summa Theologiæ.'

If this judgment seems too harsh the following paragraphs will fully confirm it. No discourtesy is meant to Mr. Tesla. But his paper has been printed. It now belongs to his readers. He must allow them to compare his philosophizing with that of his great predecessors and with the dicta of common sense.

The paper begins by asking profound questions with regard to human life. Whence comes it? What is it? Whither does it tend? "*Though we may never be able to comprehend human life, we know certainly that it is a movement, of whatever nature it may be,*" is Mr. Tesla's answer. A movement?—*one* movement? Are we sure it is a movement, and nothing else? "*Hence, wherever there is life, there is a mass moved by a force.*" A mass? A force? Why not masses, forces, hundreds of them? These beginnings which seem so definite lead to the conclusion that life is a *rhythm,* but this conclusion is at once dropped for the utterly antagonistic conception that man, mankind, is '*a mass urged on by a force.*' A force will urge a mass onward, not swing it rhythmically. We need not linger over this discrepancy, though there might be something to say, if it were worth while.

Mankind is then conceived as *one* physical mass; and Mr. Tesla's proof that this is a true conception is derived from the fact that every one of us feels sympathy with a friend who is hurt. Here is a mixing of two worlds—the world of matter and the world of feeling—which does not tend to clearness. The man born blind thought the sunset like a pleasing friendship. Swedenborg in his idea of the Grand Man who is the sum and integral of all individual men has put the question in a much truer light; but let us pass on. Man is, according to Mr. Tesla, '*a mass,*' one physical mass. Call this physical mass M. M is a quantity which can be expressed in tons or in ounces. Mankind is '*impelled in one direction*'—*one* direction!! by a force f, "*which is resisted by another force R, acting in a direction exactly opposite.*"

The idea in Mr. Tesla's mind is apparently that the force R is the reaction of the first force f. But every reaction is not only opposite to its action but equal to it, according to Newton. Not so in Mr. Tesla's universe. Reactions are opposite to, but less than actions. There is an effective force left over, which, in his scheme, imparts a velocity V to mankind, M. "*Human energy will then be given* (measured) *by the product* $\frac{1}{2} MV^2$, *in which* M is the *total mass of man in the ordinary interpretation of the term* '*mass*,' and V *is a certain hypothetical velocity which, in the present state of science, we are unable exactly to define and determine.*" How learned all this looks! and how foolish it all is! Mankind has a physical mass, no doubt. The *energy* of mankind is the sum of a million different energies, of very different *qualities* as well as of different amounts—spiritual as well as physical. These different energies, being of different kinds, cannot be expressed by a single term. Mr. Tesla's algebraic formula is mere solemn rubbish. It has absolutely no meaning.

There are three ways of increasing human energy, Mr. Tesla says: I. To increase the mass and energy of mankind more children must be born, fewer individuals must die, and the children must be of '*higher velocity*' than the parents (and *velocity* Mr. Tesla takes as exactly equivalent to *enlightenment*). Here Mr. Tesla pauses to discourage college athletics, and to say that although whisky, tea and tobacco shorten human life, yet he does not think that vigorous measures should be taken to suppress the habits of using them. On the contrary he would leave whisky alone, and improve the quality of drinking water. '*Gambling, business-rush, excitement * * * uncleanliness * * * laxity of morals * * * the society-life, modern education and the pursuits of women*' and other matters tend to diminish the mass of mankind, but want of food is the chief cause.

Cattle are food of '*low velocity*' (enlightenment) Mr. Tesla says, and he does not approve of raising cattle, therefore. '*It is certainly preferable to raise vegetables.*' Here he has forgotten his basic principle, unless, indeed, he is prepared to prove that turnips are food of 'high velocity,' *i. e.*, enlightenment. Here, again, as in the case of rhythmic motion, he no sooner lays down a principle than he abandons or neglects it for something quite different. However his vote is for vegetables, and more are wanted. To fertilize the soil more nitrogen is needed. He has an electric method for obtaining nitrogen from the atmosphere (so has Sir William Crookes) and the world's food supply is safe. All this is very well known. There is nothing new about it except the solemn manner in which it is said.

II. The second point is to reduce the force that retards the human mass. This force is a compound of ignorance, stupidity, imbecility, insanity, religious fanaticism, etc. It is not so simple then as Mr. Tesla's 'force R' with which he began. Warfare is a retarding force but Mr. Tesla thinks it will be with us for some time yet, and indulges in a short excursion on flying-machines. "*The flying-machine is certainly coming and very soon. I see no reason why a ruling power like Great Britain might not govern the air as well as the sea. I do not hesitate to say that the next years will see the establishment of an* '*air-power*,' *and its center may not be far from New York*" (possibly in Mr. Tesla's laboratory?). After a couple of pages devoted to warfare, harbor-defense, flying-machines, foreign invasion, international agreements, eternal justice, prehistoric man and his weapons, Mr. Tesla concludes that future battles will be decided by matching one complicated machine (say British) against another (say Russian).

"*Machines will meet in a contest without bloodshed, the Nations being simply interested, ambitious spectators. When this happy condition is realized peace will be assured.*" "*Bloodshed*," Mr. Tesla thinks, "*will ever keep up barbarous passions.*" Hence we must '*produce a machine capable of acting as though it were a part of a human being.*' Such a machine may be destroyed but no blood will flow. Mr. Tesla has not yet produced a machine of the sort but he means to do it.

He tells us that as a boy he noticed that whatever he thought of he saw. He visualized words in his mind. By attention he discovered that every occurrence in his mind was suggested by some previous outside occurrence or object. Hence, he was not a free agent, but played upon by his environment. He was the sport of the universe—an automaton. "*I have demonstrated, to my absolute satisfaction, that I am an automaton endowed with power of movement, which merely responds to external stimuli beating on its sense-organs, and thinks and acts and moves accordingly.*" He may be an automaton; but if he thinks that the foregoing argument proves it, he is no logician. Being an automaton himself Mr. Tesla proceeded to make another automaton. He consented to make it full-grown to save time. It was also unnecessary to endow it with the power of propagating its kind, since Mr. Tesla himself could make more machines when he wanted them. He likewise consented to make it without a mind, because a mind '*I could easily embody in it by conveying to it my own intelligence.*'

With these slight differences from the Garden of Eden Mr. Tesla's workshop has turned out a kind of electrical boat or animated bath-tub (see the cut) whose movements can be controlled from a distance. This machine '*behaved just like a blindfolded person obeying directions received through the ear.*' It had a '*borrowed mind.*' In fact, it had no mind at all, except in Mr. Tesla's confused terminology. It had the same kind of a mind as a Waltham watch. It is now Mr. Tesla's intention to build an '*Automaton*' '*which will have its own mind.*' "*It will be capable of distinguishing between what it ought and what it ought not to do.*"

Of course, such words are merely quibbles. In exactly the same sense a steam-engine has its own mind, and distinguishes what it ought from what it ought not to do. So did Maelzel's mechanical duck. So did Babbage's calculating engine. So does every device. Either the words mean nothing new; or else they are deceptive quibbles. It does not mend matters to say: '*my ideas on this subject have been put forth with deep conviction, but in a humble spirit.*'

Universal peace will be realized, he says, "*when all darkness shall be dissipated by the light of science, when all nations shall be merged into one, and patriotism shall be identical with religion, when there shall be one language, one country, one end, then the dream will have become reality.*" To bring about these desirable conclusions, an automatic fighting machine is necessary. Mr. Tesla is now engaged on the question automatically.

III. But all this while the main point has been lost sight of in divagations. How to increase the forces moving the human mass is the question. For reasons not adduced Mr. Tesla declares that '*the resultant of all these forces is always in the direction of reason.*' Every individual man is an automaton, we have seen, and will act unreasonably if played upon by certain forces. But mankind, which is made up of men, always acts reasonably. 'Tis strange; one seems to recall instances from history that refute the assertion. And indeed, Mr. Tesla himself does not really believe it. What is this busy world, he asks, but 'an immense clock-work?' A 'reasonable' clock-work! He finds, finally that "*the great problem of increasing human energy is answered by the three words: Food, Peace, Work.*" "*These three words,*" he says "*sound the key-note of the Christian Religion.*" One had supposed that Faith, Hope and Charity were the key-notes of the Christian religion; and that this religion had no message at all to a world of automatic men.

With a touching little eulogy on iron, and the prediction that aluminum is soon to take its place, and a good word for coal and for gas-engines, he passes on to the question of obtaining energy direct from the sun, and discusses the "*possibility of a self-acting engine or machine, inanimate, yet capable, like a living being, of deriving energy from the medium.*" His conclusion is that it is possible though it cannot be produced for a long time yet. It is not pressing, then, to discuss his results. We will wait until some are forthcoming.

The next paragraphs of Mr. Tesla's long paper are taken up with the description of his experiments on electrical matters, wireless telegraphy (which Marconi independently discovered and has made practical), etc. Into these we will not follow him, except to say that he claims to be able to produce electrical effects on the planets Venus or Mars by methods which he is very careful not to explain. He expects an answer, too: "*That we can send a message to a planet is certain, that we can get an answer is probable; man is not the only being in the Infinite gifted with a mind.*"

We might go on page by page, pointing out error, extravagance and bathos like the preceding. There seems to be no special need to go further. It should be evident to any impartial reader that the value of Mr. Tesla's general philosophical speculations and opinions is exactly *nil*. The value of his work in electricity must be judged by experts. The weight of his predictions as to future discoveries would be greater if his judgment on things in general were less unsound. It is passing strange that such loose reasonings can find a publisher. It is to be hoped that they will gain little credence from his readers. A line from Plato's Republic applies here (changing a word) to wit: "I verily believe that it is a more venial offence to be the involuntary cause of death to a man than to deceive him concerning scientific truth."

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BOTANICAL NOTES.

A NEW LABORATORY MANUAL.

Dr. Clements and Principal Cutter, the former of the botanical staff of the University of Nebraska, and the latter of the Beatrice (Nebr.) High School have brought out what must prove to be a very helpful book for those teachers of Elementary Botany who wish to give their pupils a good course in laboratory work. There has been an increasing demand on the part of University professors that the high schools should lay such a solid foundation in the sciences that the subsequent work in the university could safely be built upon it. This has wrought a radical change in the methods of teaching chemistry and physics in the high schools which fit their pupils for university entrance. For many years some of the botanists have been demanding laboratory training in elementary botany for Freshmen entrance, but while the schools have made some progress, it is a curious fact that no serious attempt has hitherto been made to supply the high schools with a scientific manual comparable to the many excellent works of this character in chemistry and physics.

The authors of the 'Laboratory Manual of High School Botany' have attempted to make a book which is at once practicable in the average high school, as well as strictly scientific. The pupil who covers the work here laid out will be prepared to go forward in college and university classes without the necessity of unloading and unlearning a lot of rubbish, while at the same time if he should go no further with his studies he has had the satisfaction of knowing that he is in the possession of a considerable body of useful information in regard to the structure and actions of plants. The general plan of the book may be obtained by a glance at the titles of the chapters, as follows: General Directions, Plant Structure, or Histology, Structure and Classification, Phytogeography, Synopsis of the Larger Groups of the Vegetable Kingdom, Physiology, Appendix (containing suggestions to teachers), and Glossary.

ORIGIN OF THE HIGHER FUNGI.

Mr. George Massee, the well-known mycologist of Kew, speculates (in Linn. Soc., *Jour. Bot.*, vol. xxxiv., p. 438) as to the origin of the group of fungi known as the Basidiomyceteae, which includes those genera generally regarded as the highest of the hysterophytes, viz, the puff-balls and their relatives, and the various forms of toadstools and mushrooms. Finding that the conidial fructification of certain Ascomyceteae bears some resemblance to the spore-bearing tissues of the Basidiomyceteae, he finds a series of more or less obvious gradations, and arrives at the conclusion that there is a genetic connection between them. According to this view some plants are Ascomyceteae as to their ascigerous, and Basidiomyceteae as to their conidial fructifications. While ingenious, it is not likely that this theory will be generally accepted.

SUPPLEMENT TO NICHOLSON'S DICTIONARY OF GARDENING.

Stimulated, perhaps, by the publication of Bailey's 'Cyclopedia of American Horticulture,' the publisher of Nicholson's 'Dictionary of Gardening' (Gill, London) announces a '1900 Supplement' which is to appear in two volumes. The first of these supplementary volumes has come to hand, and fully justifies the statement of the publisher as to the quality of subject matter and mechanical execution. The illustrations are superb, in many cases being reproduced directly from photographs. Upon the appearance of the second volume a more extended notice will be made.

NEW EDITION OF PRANTL'S LEHRBUCH.

Dr. Pax of Breslau has brought out the eleventh edition of the well-known 'Lehrbuch der Botanik' of the lamented Dr. Prantl, first published in 1874, and much used some years ago in American colleges. It speaks well for the teachers of botany that this book has proved so popular as to have gone through so many editions, in spite of the fact that it has not departed essentially from the scientific sequence of topics, neither has it attempted to introduce popular 'natural history' features in place of the more difficult laboratory requirements. The book contains three 'parts,' the first of which deals with structural, the second with physiological, and the third with systematic botany. It may still be held up as a model worthy of being followed by makers of botanical text-books.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE COAL FIELDS OF CHINA.

PROFESSOR DRAKE, of Tien-tsin, has lately published a report on the coal fields in Shan-si province, which he visited last autumn, especially those around Tse-chau, which were first made known to the world by Baron von Richthofen in 1870, and for the working of which concessions have been granted to an Anglo-Italian company. According to the abstract in the London *Times*, the journey from the coast is made across low-lying plains, and then a plateau is ascended, on which the coal measures are found. The workable coal lies in one bed, about 250 feet above a flint-bearing limestone stratum, below which it is possible that there is also coal. In Tse-chau the average thickness of seam is probably not less than 22 feet, and at one place it is worked through a shaft 329 feet deep. Streaks of shaly coal are common in the part being mined, but there is no waste coal taken out, and the proportion of ash is little more than 10 per cent. There is no waste material in the bed in any of the mines. Professor Drake estimates that within the 150 square miles around Tse-chau there are about 3000 million metric tons of coal, and it "must be remembered that this area is only a little of the ragged edge of the great coal fields of Shan-si. Most of Shan-si has been found underlaid by large coal beds. Richthofen estimates that the anthracite coal alone of Shan-si amounts to 630,000 million tons, and that the coal area is greater than that of Pennsylvania." All the Tse-chau coal is anthracite, with a specific gravity of 1.5, and it is hard enough to support any weight put upon it in the blast furnace. The proportion of sulphur is uniformly low, and that of ash also. A cursory examination of the outcrops showed the iron ore stratum to be 2 feet to 3 feet in thickness; the workings are limited to this narrow strip because the ore beds lie near the surface and can be mined by open pits, whereas elsewhere deep shafts and long tunnels would be needed. But the small quantity of ore will probably never justify extensive mining at a depth. Besides coal and iron ore the district yields fire clays of good quality for bricks and cheap pottery. These are now much used by the Chinese for household utensils. Sandstone occurs in abundance and is extensively used by the Chinese; its fault is great friability. Massive limestones are in great abundance and of good quality. They vary in color from light gray to blue and almost black. The soil is largely *loess*, and is therefore fertile and highly cultivated, a dense population being supported by agriculture. The industries are centered round the mines. Nearly all the coal is mined through shafts varying in depth from 50 ft. to over 300 ft. Very little is mined through inclines. No steam is used for raising the coal to the surface, and explosives are not employed. The work is done with the windlass and pick. Tunnels are run through the bed from the bottom of the shaft, and at intervals along the tunnels large quantities of coal are removed, leaving circular chambers 40 ft. to 50 ft. in diameter, and thus about 50,000 tons a year are brought to the surface in the district. For local use, the coal is carried away in little carts drawn by oxen, but most of it is taken down the mountains by pack animals, as the paths are very steep and rough. It is 20 miles to the plains; the paths are about 13 ft. wide and are paved with stone. But "the great thickness and the almost horizontal position of this coal bed make it practicable, as suggested by Richthofen, for other Shan-si coal beds, to run long lines of railroad tunnels through the bed, and load the cars in the mines for distant transportation."

SCIENTIFIC NOTES AND NEWS.

THE British Association will meet next year at Glasgow, beginning on September 11th under the presidency of Professor A. W. Rücker. In 1902 the meeting will be at Belfast.

WE regret to learn that up to the present time, but 30 complete subscriptions have been received in the United States for the International Catologue of Scientific Literature. The successful beginning of the project is dependent upon at least 45 subscriptions from the United States, and it is necessary that these should all be in before the end of September. The Catalogue will comprise 17 volumes per annum, the subscription per annum is $85, and, in order to give the undertaking some sort of permanence, it is desired that these subscriptions shall be for five years. All subscriptions from the United States should be addressed to the Secretary of the Smithsonian Institution, Washington, D. C.

PROFESSOR H. T. TODD, having reached the age limit, has retired from the directorship of the Nautical Almanac. Professor S. J. Brown, astronomical director of the U. S. Naval Observatory, has untertaken the duties of the office.

Popular Astronomy quotes from the 'Navy Register' of 1900 the rank of all the mathematical officers in the navy on January 1, 1900. They are as follows: On the active list 'Rank of Captain': Professors Hendrickson, Todd and Oliver. 'Rank of Commander': Professors Brown, Rawson, Alger and Dodge. 'Rank of Lieutenant': Professors Paul, Skinner, See and Updegraff. On the retired list: 'Rank of Rear Admiral': William Harkness. 'Rank of Captain': Professors Newcomb, Hall and Eastman. 'Rank of Commander': Professors Frisby, Prudhomme and Rice.

PROFESSOR BALDWIN SPENCER has been given leave of absence from Melbourne University to study the ethnology of the natives of the northern part of South Australia.

M. FAYE, the eminent French astronomer, has been elected a foreign member of the Reale Accademia dei Lincei of Rome.

PROFESSOR E. A. SCHÄFFER has retired from the position of General Secretary of the British Association which he has held in conjunction with Sir William Roberts-Austin. Dr. D. H. Scott has been elected to the vacant place.

DR. J. M. DA COSTA, formerly professor of the theory and practice of medicine at the Jefferson Medical College, died near Philadelphia on September 11th. He was perhaps the most prominent physician in Philadelphia, and was the author of numerous contributions to pathology, his work on 'Medical Diagnosis' having passed through numerous editions and having been translated into several foreign languages.

MR. WM. SAUNDERS, the well-known horticulturist, died at Washington, on September 11th, in his 78th year. He had been connected with the U. S. Department of Agriculture since its organization in 1862. He was well-known as a landscape gardener, having planned Fairmount Park in Philadelphia, and done much similar work at Washington and elsewhere.

WE learn from *Popular Astronomy* of the death of Mr. David Flannery, of Memphis, Tenn. He was interested in astronomy and had made observations of variable stars.

ACCORDING to *Popular Astronomy* the will of Professor Piazzi Smyth makes provision for the publication of his spectroscopic manuscripts, and also for the assistance or promotion every ten or twenty years of an exceptional expedition for the study of some particular branch of astronomical spectroscopy at mountain elevations of not less than 6000 feet.

THE will of Mr. Charles H. Smith of Providence contains the following public bequests: $3000 to the Rhode Island Historical Society, $2000 to the Rhode Island Horticultural Society, $1000 to the city public schools for the purchase of microscopes, $3500 to Brown University, and real estate valued at upwards of $200,000 for the maintenance of the botanical specimens in the city park.

THOSE who have seen reference made to a forthcoming bulletin on the fishes of Porto Rico, to be issued by the U. S. Fish Commission, may not know that the publication has been delayed by a fire in New York, in which the drawings in black and white and such plates as had been engraved were destroyed.

The fine colored plates, however, being in the hands of another firm, were uninjured. Other drawings have been made to take the place of the more important of those destroyed and the work will be issued as soon as possible.

At the recent meeting of the British Association a committee was appointed to consider the following resolutions: "That in view of the opportunities of ethnographical inquiry which will be presented by the Indian census, the council of the Association be requested to urge the Government of India to make use of the census officers for the purposes enumerated below, and to place photographers at the service of the census officers: (1) to establish a survey of the jungle races, Bhils, Gonds, and other tribes of the central mountain districts; (2) to establish a further survey of the Naga, Kuki, and other cognate races of the Assam and Burmese frontiers; (3) to collect further information about the vagrant and criminal tribes, Haburas, Beriyas, Sansiyas, etc., in North and Central India; (4) to collect physical measurements, particularly of the various Dravidian tribes, in order to determine their origin; and of the Rajputs and Jats of Rajputana and the Eastern Punjab, to determine their relation with the Yu-echi and other Indo-Scythian races; (5) to furnish a series of photographs of typical specimens in the various races, of views of archaic industries, and of other facts interesting to ethnologists."

The great meteor of August 25th is reported to have fallen near Rangeley Lake, Me., exploding within a few feet of the hotel and disappearing, not a fragment having been discovered by a prolonged search.

The question of admitting women as members of the general and sectional committees of the British Association was brought up at the recent meeting and carried by a considerable majority.

We are glad to note articles in the New York *Evening Post* and the Boston *Evening Transcript* urging the importance of a bureau of standards. The item establishing the bureau submitted by Secretary Gage was generally favored by members of Congress and would doubtless have been passed had it not been for the wish to prevent a further increase in expenditures. If the measure is adequately discussed there is every reason to believe that it will be passed next winter.

A meeting of Government officials and meteorological and agricultural authorities is soon to take place at Hamburg, to discuss the introduction of a telegraphic service for German agriculture.

The *Windward* was expected to reach St. Johns at about the middle of the present month, but a short delay will not be surprising as it started late, owing to some difficulty with the machinery, and was subsequently delayed by ice along the coast of Labrador. The arrival of the steamship is awaited with interest and some anxiety as it will bring news not only of the return of Peary, but also of Captain Sverdrup and Dr. Stein. The former has the *Fram* provisioned for five years, with a crew of twelve men. He planned to round the northern boundary of Greenland and to make his way down its unknown east coast to Cape Bismarck. It is said that the expedition under Dr. Robert Stein of the U. S. Geological Survey, who is accompanied by Mr. Leopold Kann of Cornell University and Mr. Samuel Warmbath of Harvard University was poorly equipped and left in a dangerous position. Lieutenant Peary himself expected to establish his last depôt at Cape Hecla, the most northerly point of Grinnell Land just beyond the 82d parallel, whence he intended to advance with Eskimo and sleds as far north as possible.

It is reported in the daily papers that Captain Bernier, who has lately returned to Quebec from Newfoundland, states that when there he examined all the vessels engaged in the whaling business to select one for his proposed North Pole expedition. He says that none were considered by him strong enough to resist the pressure of the Polar ice. He has, therefore, proposed that the Canadian government build a suitable vessel out of the grant that has been promised. Captain Bernier says that his offers of assistance, exclusive of the government grant, now aggregate $25,000, and that the merchants of Quebec will donate supplies worth $6000 or $7000.

News has been received from the Liverpool

Expedition sent to Nigeria to the effect that all the members are perfectly well, although they have spent four months in districts where malaria is specially prevalent and deadly. They have not kept the fever off by the use of quinine, and they attribute their immunity to the careful use of mosquito nets at night. Experiments are reported in the *Archivio per le Scienze Medichi*, abstracted in the New York *Medical Record*, of an experiment carried out by Eugenio di Mattei on himself and four others. A hut situated in an extremely malarial region, infested by mosquitoes, was chosen, and here the five slept for thirty-two nights. Their work during the day was arduous, their food scanty, their accommodations were uncomfortable; they took no quinine or other medicament, but their hut was so completely protected by wire gauze that no mosquitoes were able to obtain access. No one of the five contracted malaria, although other workmen sleeping in the neighborhood and unprotected from the mosquitoes, suffered from grave forms of the disease.

In 1898 there was mined in the United States somewhat over nineteen million tons of iron ore, which was the largest quantity up to that time ever produced in a single country in a single year. But according to the announcement recently made by the U. S. Geological Survey, the production of iron ore in the United States was 24,683,173 tons, an increase of 27 per cent. over 1898. In spite of this large increase the price is about 25 per cent. higher than in 1898.

Dr. Reginald A. Fessenden writes as follows to the *Electrical World* referring to patents by Mr. Tesla which have been widely discussed in the daily press: "With reference to your article on 'Insulation by Freezing,' in the issue of August 25th, may I be permitted to point out that the patents referred to are invalid, as this method was fully described in my paper on 'Insulation and Conduction,' read before the American Institute of Electrical Engineers in 1898, and printed in its 'Transactions' (Trans. A. I. E. E., 1898, page 14). The passage is as follows: "The second (plan) occurred to the writer on reading Elihu Thompson's article on the use of liquid air as an insulator. It is this: Since ice at only 12 degrees below freezing has a specific resistance of over 1000 megohms, *i. e.*, as good as some brands of insulation, why not make the conductors hollow, lay them in a trench filled with water, pass cold brine through the pipes, use the brine for cooling houses, making ice, etc., and let the frozen water act as the insulator. A rough calculation shows that this is commercially feasible, even neglecting all sources of profit from the furnishing of the brine, *i. e.*, if it were used only for cooling the pipes. After making all allowance for friction of fluid, cost of power, etc., the balance comes at the right end, if the line is always fully loaded.'' This was published more than two years prior to the date of application of said patents, the said date being June 15, 1900.

The report of the Principal Chemist of the Government Laboratory of Great Britain upon the work of the laboratory for the year ended March 31st last has been issued as a Parliamentary paper. According to an abstract in the London *Times* it appears that in the Customs Department during the past year, 226 samples of tea, representing 3322 packages, were found to contain exhausted leaves, or to be mixed with sand or other substances within the meaning of the Act, and were therefore refused admission for home consumption. Of these 3322 packages, 2274 were exported and 1048 destroyed. Eight thousand four hundred and eighteen samples of tobacco, tea, coffee, soaps, drugs, varnishes, etc., were examined during the 12 months; 167,080 samples of beer, spirits and wines were examined in the same period. The number of analyses and examinations made in the Excise branch amounted to 68,287, or 1864 more than in the preceding year. Seven thousand five hundred and two samples of wort in various stages of fermentation had been examined to check the declaration of gravity made by the brewer. In 614, or rather more than 8 per cent. of these cases, the original gravity was found one degree or more above that declared by the trader or found by the officer. In 583 cases the increased gravity was less than five degrees, in 26 cases five degrees and less than ten, and in five cases ten degrees and upwards. Two thousand three hundred and eighty-six samples of finished beer taken from 1223 publicans were analyzed, and 319 or 13 per cent. of the samples were found to have been diluted with water or otherwise adulterated. Ninety-five samples of tobacco taken from manufacturers and dealers were analyzed for adulteration generally, and 20 of them were found to be adulterated with liquorice or glycerine. All the adulterated samples were apparently either smuggled cake cavendish or cut tobacco, which bore no label to show it had paid the proper rate of duty. While in 1841, when the population was 26,700,000, the quantity of tobacco cleared for consumption was 23,096,281 lb., or 13¾ oz. per head of the population, the quantity in 1900, with a population of 40,835,000, was 80,955,037 lb., or 1lb. 15¾ oz., per head. In the 'other Government Department's' branch the number of samples examined in connection with the Board of Agriculture had increased from 1600 in the year ended March 31, 1899, to 1745 during the last year. The increase was due partly to the new Food and Drugs Act. One thousand three hundred and ninety-three samples of imported butter were examined. Only six samples gave distinctly abnormal results. A large number of butters contained boric preservative and were artificially colored. As usual, it was found that the use of boric acid is most prevalent in France, Belgium, and Australia, and is very common also in Holland. The most frequent coloring-matter is annatto, but the use of coal-tar yellows appears to be on the increase, and is especially prevalent in Holland, the United States and Australia. One hundred and thirty-two samples of imported margarine were analyzed. The bulk of the margarine imported comes from Holland, and it is usually made with cottonseed oil, contains boric preservative, and is artificially colored with a coal-tar yellow. In all 1745 samples of butters, margarines, cheese, etc., were examined.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Samuel Mather, of Cleveland, has offered to give Kenyon College at Gambier, Ohio, $10,000 for every $15,000 secured from other sources. This has resulted in a gift of $15,000 from Mr. J. P. Stevens for a library fund.

With the opening of the scholastic year this month the Christian Brothers in their colleges in the United States enter upon the new order prescribed for them by their superiors in France, who have decided that hereafter modern languages shall replace the classics. Manhattan College, New York, and others of the best Catholic Colleges giving the B.A. degree must follow these directions, though it is said that they may cause a division in the Order.

The Congress of British Chambers of Paris' which met at Paris this month adopted the following resolution: "That this meeting endorses the following resolution, which was adopted at the Congress of Chambers of Commerce of the Empire in June, 1900: 'That it is most desirable to take steps to urge the extension of technical and commercial education throughout the Empire, and that wherever possible this education should be placed under efficient public control; and that this Congress is of opinion that the utmost effort should be made throughout the Empire to encourage and furnish facilities for commercial education as a branch of technical and scientific study, and that the Home and Colonial Governments be moved to give aid thereto and ample powers of contribution out of local resources; and, further, it is very desirable that Chambers of Commerce should be represented on Boards of Education in order to advance the interests of commercial education.'"

Dr. Oustalet, assistant in the Paris Natural History Museum, has been made professor of zoology (mammals and birds) in the Museum in succession to the late M. Milne-Edwards.

Professor Craig of the Ames Agricultural College and formerly horticulturist of the Dominion Experiment Farm at Ottawa has been called to Cornell University for work in horticulture.

Professor Wendell Paddock of the Geneva Experiment Station has been elected professor of horticulture in the Colorado Agricultural College.

Professor Percy J. Parrot of the Kansas Agricultural College has been appointed entomologist at the Geneva Experiment Station.

SCIENCE

FRIDAY, SEPTEMBER 28, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

THE INTERNATIONAL CATALOGUE.

AT the end of last month the Smithsonian Institution sent out a circular letter inviting various bodies in America to subscribe for a period of five years to the proposed International Catalogue of Scientific Literature. At an early stage of the deliberations concerning the Catalogue, it became evident that the necessary financial basis for the undertaking could not be secured on the plan of direct contributions from the several countries interested in the matter. An adequate basis however presented itself in the form of guaranteed subscriptions for a certain period; and it was calculated that a guarantee of subscriptions of about 300 complete sets would justify the work being begun. The German government undertook to subscribe for 45 complete sets for five years; other governments undertook subscriptions of lesser amounts; the Royal Society guaranteed that 45 copies should be subscribed for in Great Britain and Ireland; and, at the close of the International Conference, in June last, the financial prospects were found to be such that if subscriptions for 45 complete sets for five years, in the United States of America, could be assured, the work might at once be put in hand. The Smithsonian Institution undertook the task of asking for subscriptions; hence the circular in question.

Visiting Washington on Tuesday, last, I had the extreme gratification of learning that more than 45 complete sets (or the equivalent) had been already subscribed. The Catalogue, therefore, will be begun at once. Considering that the appeal of the Smithsonian Institution was made under most unfavorable conditions, namely in the middle of the vacation, I cannot but regard the result as a most encouraging proof that America is determined to give its characteristic support to what I think I may venture to call a most important international scientific undertaking. And I can myself all the more fully appreciate the value of this support because I am well aware that several features of the scheme for the conduct of the Catalogue have been severely criticised in this country, in which above all other countries much thought and labor has been spent on the problems of indexing.

May I take the opportunity of expressing on the part of the Royal Society of London a grateful recognition of that support, and at the same time of making, on my own responsibility, a few remarks on the whole subject.

1. Two different plans of indexing scientific literature by international cooperation present themselves. One is that this or that country should undertake the indexing of this or that branch of science, taking in hand the whole literature of that branch, the several countries agreeing among themselves to cover in this way the whole field of science. Another plan is for each country to collect the data of its own literature in all branches of science and for the final collation and editing of all the literature to be conducted in some international central office. Each plan has its advantages and disadvantages. The International Conference adopted the second plan; but this has necessarily had the drawback that it could not provide at once and directly for attaching to its organization undertakings already existing upon the other plan. An alliance of such organizations with its own could only be brought about, if at all, by prolonged and difficult negotiations, however desirable such an alliance might seem.

2. The Catalogue is intended for two classes: for the scientific investigator and for libraries. So far perhaps the chief attention has been directed to the needs of the scientific investigator, as was natural seeing that the most active workers in the undertaking have been men of science engaged in investigation. But I think I am justified in saying that the men of science in question are fully aware of the great importance of making the Catalogue of value to libraries as well as to individual workers in science, and trust that in time it may be made equally useful to both.

3. At the first Conference it was decided that the Catalogue should be in a 'card' form as well as in a book form; but it was subsequently decided to give up the 'card' form *for the present.* This decision was based simply on the complexity of organization and expense which the card issue would involve. It was thought wiser to begin at least with the simpler book issue alone; but it is hoped by some that should the simpler enterprise prove successful, and the machinery be found to be manageable, the issue of cards may at some future day be undertaken.

4. No part of the scheme has met with more severe criticism than the schedules of classifications. With regard to these I venture to say that few persons, save those behind the scenes, can know the amount of labor which has been spent upon them. In the course of my life I have met with various things fertile in disagreements; but for a real apple of discord, nothing that I know of comes near to a schedule of classification; and it is, I imagine, unnecessary to say that the schedules as adopted represent the results of compromises, compromises in

some cases at least come to with much misgiving.

It must be remembered that though some of the schedules in question have been tested (and corrected) by being actually applied to a considerable mass of literature, they will all be severely tested by the actual experience even of the first year.

Speaking now entirely for myself and giving only my own opinion, I cannot expect otherwise than that the experience of the first year (or possibly even a shorter experience) will compel the International Council to authorize changes in the schedules. This, if done, will have the disadvantage of making the second year's Catalogue not wholly homogeneous with the first year's; but this I venture to think will be more than balanced by the better character of the second year's issue. Similarly with the third and fourth years. When the fifth year is reached, the Catalogue if it is to answer the expectations which it has raised may be expected to have passed through at least its main metamorphoses and to have assumed its adult form. If at the end of the fifth year, the office will be able, and it is hoped it will be able, to issue not only the Catalogue for the fifth year, but also a combined catalogue of all the five years taken together, then if that five year Catalogue and the fifth year Catalogue are not fully worth, both to workers and to libraries, the money asked for them, the whole enterprise had better be abandoned. And I would venture to urge very earnestly that the worth of the Catalogue should not be judged by its first issues ; they must necessarily be most imperfect; they can only present not the achievement but the promise of what is intended.

5. As a substitute for cards, it was suggested that a bimonthly issue might be adopted, or an issue on an accumulative plan ; but the Conference decided in the first instance to be content with the simple annual book issue. There seems, however, to be no reason why special arrangements should not be made by which a subscriber should receive the Catalogue printed on one side only of the paper. Scissors and paste would soon convert this into a card catalogue.

6. The subscriptions asked for by the Smithsonian Institution, namely for complete sets of the 17 volumes a year, for five years, represent part of the financial basis of the enterprise. The calculations made show that an annual sale of about 300 sets of 17 volumes representing 17 branches of science at an *average cost* per volume of £1, *i. e.*, £17 or $85 for a complete set will put the whole undertaking on a sound financial basis. The price of each volume will of course not be the same, some volumes (*e. g.*, Zoology) will be much larger than others (*e. g.*, Mineralogy). The exact price of each volume cannot be determined until the size, *i. e.*, the number of entries in that volume, is approximately known. Hence at present subscriptions for individual volumes at a stated price cannot be invited. Ultimately of course not only each volume, but in certain cases at least, parts of a volume, *i. e.*, indices of subdivisions of a branch of science will be offered for sale. The prices and conditions of sale will be determined hereafter.

M. FOSTER.

GARRISON-ON-HUDSON, N. Y.,
September 21, 1900.

ADDRESS OF THE PRESIDENT OF THE BOTANICAL SECTION OF THE BRITISH ASSOCIATION.

THERE has been considerable difference of opinion as to whether the present year marks the close of the nineteenth or the beginning of the twentieth century. But whatever may be the right or the wrong of this vexed question, the fact that the year-date now begins with '19' instead of with '18' suggests the appropriateness of devoting an occasion such as the present to a review of the century which has closed, as some will have it, or, in the opinion of others, is about to close. I therefore propose to address you upon the progress of Botany during the nineteenth century.

I am fully conscious of the magnitude of the task which I am undertaking, more especially in its relation to the limits of time and space at my disposal. So eventful has the period been that to give in any detail an account of what has been accomplished during the last hundred years would mean to write the larger half of the entire history of Botany. This being so, it might appear almost hopeless to attempt to deal with so large a subject in a presidential address. But I trust that the very restrictions under which I labor may prove to be rather advantageous than otherwise, inasmuch as they compel me to confine attention to what is of primary importance, and thus to give special prominence to the main lines along which the development of the science has proceeded.

STATISTICS.

We may well begin with what is, after all, the most fundamental matter, viz, the relative numbers of known species of plants at the beginning and at the end of the century. It might appear that the statistics of plants was a subject susceptible of very simple treatment, but unfortunately this is not the case. It must be remembered that a 'species' is not an invariable standard unit, like a pound or a pint, but that it is an idea dependent upon the subjectivity of individual botanists. For instance, one botanist may regard a certain number of similar plants as all belonging to a single species, whilst another may find the differences among them such as to warrant the distinction of as many species as there are plants. It is this inevitable variation in the estimation of specific characters which renders it difficult to deal satisfactorily with plants from the statistical point of view. However, the following figures may be regarded as giving a fair idea of the increase in the number of 'good' species of living plants.

It is generally stated that about 10,000 species of plants were known to Linnæus in the latter half of the eighteenth century, of which about one-tenth were Cryptogams; but so rapid was the progress in the study of new plants at that time that the first enumeration of plants published in the nineteenth century, the 'Synopsis' of Persoon (1807), included as many as 20,000 species of Phanerogams alone. Turning now to the end of the century, we arrive at the following census, for which I am indebted mainly to Professor Saccardo (1892) and to Professor de Toni who has kindly given me special information as to the Algæ:

Species of Phanerogams indicated in Bentham and Hooker's 'Genera Plantarum' (Durand, 'Index,' 1888).

Dicotyledons	78,200
Monocotyledons	19,600
Gymnosperms	2,420
	100,220
Estimated subsequent additions (Saccardo)	5,011
Total Phanerogams	105,231

Species of Pteridophyta (indicated in Hooker and Baker's 'Synopsis'; Baker's 'New Ferns' and 'Fern Allies').

Filicinæ (including Isoëtes), about	3,000
Lycopodinæ, about	432
Equisetinæ, about	20
Total Pteridophyta	3,452

Species of Bryophyta (Saccardo's Estimate).

Musci	4,609
Hepaticæ	3,041
Total Bryophyta	7,650

Species of Thallophyta.

Fungi (including Bacteria) (Saccardo)	39,663
Lichens (Saccardo)	5,600
Algæ (incl. 6000 Diatoms) (de Toni)	14,000
Total Thallophyta	59,263

Adding these totals together—

Phanerogams	105,231
Pteridophyta	3,452
Bryophyta	7,650
Thallophyta	59,263
we have a grand total of	175,596

as the approximate number of recognized species of living plants.

These figures are sufficiently accurate to show how vast have been the additions to the knowledge of plants in the period under consideration, and they afford much food for thought. In the first place, they indicate how closely connected has been the growth of this branch of Botany with the exploration and opening-up of new countries which has been so characteristic a feature of the century. Again, no one can consider these figures without being struck by the disparity in the numbers of species included in the different groups; a most interesting topic, which cannot, however, be entered upon here. It must suffice to point out in a general way that the smaller groups represent families of plants which attained their numerical zenith in long past geological periods, and are now decadent, whilst the existing flora of the world is characterized by the preponderating Angiosperms and Fungi.

We may venture to cast a forward glance upon the possible future development of the knowledge of species. Various partial estimates have been made as to the probable number of existing species of this or that group, but the only comprehensive estimate with which I am acquainted is that of Professor Saccardo (1892). He begins with a somewhat startling calculation to the effect that there are at least 250,000 existing species of Fungi alone, and he goes on to suggest that probably the number of species belonging to the various other groups would amount to 150,000; hence the total number of species now living is to be estimated at over 400,000. On the basis of this estimate it appears that we have not yet made the acquaintance of half the contemporary species; so that there remains plenty of occupation for systematic and descriptive botanists, especially in the department of Fungology. It is also rather alarming, in view of the predatory instincts of so many of the Fungi, to learn that they constitute so decided a majority of the whole vegetable kingdom.

In spite of the great increase in the number of known species, it cannot be said that any essentially new type of plant has been discovered during the century. So far as the bounds of the vegetable kingdom have been extended at all, it has been by the annexation of groups hitherto regarded as within the sphere of influence of the zoologists. The most notable instance of this has occurred in the case of the Bacteria, or Schizomycetes, as Naegeli termed them. These organisms, discovered by Leeuwenhoek 200 years ago, had always been regarded as infusorian animals until, in 1853, Cohn recognized their vegetable nature and their affinity with the Fungi. These plants have acquired special importance, partly on account of the controversy which arose as to their supposed spontaneous generation, but more especially on account of their remarkable zymogenic and pathogenic properties, so that bacteriology has become one of the new sciences of the century.

CLASSIFICATION.

Having gained some idea of the number of species which have been recognized and described during the century, the next point for consideration is the progress made in the attempt to reduce this mass of material to such order that it can be intelligently apprehended; in a word, to convert a mass of facts into a science; 'Filum ariadneum Botanices est systema, sine quo chaos est Res Herbaria' (Linnæus).

The classification of plants is a problem which has engaged attention from the very earliest times. Without attempting to enter into the history of the matter, I may just point out that, speaking generally, all the earlier systems of classification were more or less artificial, the subdivisions being based upon the distinctive features of one set of members of the plant. When I say that of all these systems that proposed by Linnæus (1735) was the most purely artificial, I do not imply any reproach: if it was the most artificial, it was at the same time the most serviceable, and its author was fully aware of its artificiality. This system is generally regarded as his most remarkable achievement; but the really great service which Linnæus rendered to science was the clear distinction which he for the first time drew between systems which are artificial and those which are natural. Recognizing, as he did, his inability to frame at that period a satisfactory natural system, he also realized that with the increasing number of known plants some more ready means of determining them was an absolute necessity, and it was for this purpose that he devised his artificial system, not as an end, but as a means. The end to be kept in view was the natural classification: 'Methodus naturalis est ultimus finis Botanices' is his clearly expressed position in the 'Philosophia Botanica.'

There is a certain irony in the fact that the enthusiastic acceptance accorded to his artificial system throughout the greater part of Europe contributed to postpone the realization of Linnæus's cherished hopes with regard to the attainment of a natural classification. It was just in those countries, such as Germany and England, where the Linnean system was most readily adopted that the development of the natural system proceeded most slowly. It was in France, where the Linnean system never secured a firm hold, that the quest of the natural system was pursued; and it is to French botanists more particularly that our present classification is due. It may be traced from its first beginnings with Magnol in 1689, through the bolder attempts of Adanson and of Bernard de Jussieu (1759), to the relatively complete method propounded by Antoine Laurent de Jussieu in his 'Genera Plantarum,' just 100 years later.

The nineteenth century opened with the struggle for predominance between the Jussiean and the Linnean systems. In England the former soon obtained considerable support, notably that of Robert Brown, whose 'Prodromus Floræ Novæ Hollandiæ,' published in 1810, seems to have been the first English botanical work in which the natural system was adopted; but it did not come into general use until it had been popularized by Lindley in the thirties.

Meantime the Jussiean system had been extended and improved by Auguste Pyrame de Candolle (1813–24). It is essentially the Candollean classification which is now most generally in use, and it has been immortalized by its adoption in Bentham and Hooker's 'Genera Plantarum,' one of the great botanical monuments of the century. In Germany, however, it has been widely departed from, the system there in vogue being based upon Brongniart's modification (1828, 1850) of de Candolle's method as elaborated successively by Alex Braun (1864), Eichler (1876–83), and Professor Engler (1886, 1898). It must be admitted that for the last fifty years the further evolution of the natural system, at any rate so far as Phanerogams are concerned, has been confined to Germany.

One of the more important advances in the classification of Phanerogams was based upon Robert Brown's discovery in 1827 of the gymnospermous nature of the ovule in Conifers and Cycads, which led Brongniart (1828) to distinguish these plants as 'Phanérogames gymnospermes'; and although the systematic position of these plants has since then been the subject of much discussion, the recognition of the Gymnospermæ as a distinct group of archaic Phanerogams is now definitely accepted.

Moreover, the greatly increased knowledge of the Cryptogams has involved a considerable reconstruction in the classification of that great sub-kingdom. One of the most striking discoveries is that first definitely announced by Schwendener (1869) concerning Lichens, to the effect that the body of a Lichen consists of two distinct organisms, an Alga and a Fungus, living in symbiosis ; a discovery which was so nearly made by other contemporary botanists, such as de Bary, Berkeley, and Sachs, and which can be traced back to Haller and Gleditsch in the eighteenth century.

But the discoveries which most affected the classification of the Cryptogams are those relating to their reproduction. Whilst it had been recognized, almost from time immemorial, that Phanerogams reproduce sexually, sexuality was denied to Cryptogams until the observations on Liverworts and Mosses by Schmidel and by Hedwig (of whom it was said that he was born to banish Cryptogamy) in the eighteenth century ; and even as late as 1828 we find Brongniart classifying the Fungi and Algæ together as 'Agames.' But in the middle third of the nineteenth century, by the labors of such men as Thuret, Pringsheim, Cohn, Hofmeister, Naegeli, and de Bary, the sexuality of all classes of Cryptograms was clearly established. It is worthy of note that, although the sexuality of the Phanerogams had been accepted for centuries, yet the details of sexual reproduction were first investigated in Cryptogams. For it was not until 1823 that Amici discovered the pollen-tube, and it was more than twenty years later (1846) before he completed his discovery by ascertaining the true significance of the pollen-tube in relation to the development of the embryo ; whilst it remained for Strasburger to observe, thirty years later, the actual process of fertilization.

The discovery of the reproductive processes in Cryptogams not only facilitated a natural classification of them, but had the further very important effect of throwing light upon their relation to Phanerogams. Perhaps the most striking botanical achievement of the nineteenth century has been the demonstration by Hofmeister's unrivaled researches (1851) that Phanerogams and Cryptogams are not separated, as was formerly held, by an impassable gulf, but that the higher Cryptogams and the lower Phanerogams are connected by many common features.

The development of the natural classification, of which an account has now been given, proceeded for the most part on the assumption of the immutability of species. As Linnæus expressed it in his 'Fundamenta Botanica,' 'species tot numeramus, quot diversæ formæ in principio sunt creatæ.' It is difficult to understand how, with the point of view, the idea of affinity between species could have arisen at all ; and yet the establishment of genera and the attempts at a natural system prove that the idea was operative. The nature of the prevalent conception of affinity is well conveyed by Linnæus's aphorism, 'Affines conveniunt habitu, nascendi modo, proprietatibus, veribus, usu.'

But a conviction had been gradually growing that the assumed fixity of species was not well founded, and that, on the contrary, species are descended from preexistent species. This view found clear expression in Lamarck's 'Philosophie zoologique,' published early in the century (1809), but it did not strongly affect public opinion until after the publication of Darwin's 'Origin of Species' in 1859. Regarded from this point of view the problems of classification have assumed an altogether different aspect. Affinity no longer means mere similarity, but blood-relationship depending upon common descent. We no longer seek a 'system' of classification; we endeavor to determine the mutual relations of plants. The effect of this change has been to stimulate the investigation of plants in all their parts and in all stages of their life, so as to attain that complete knowledge of them without which their affinities cannot be accurately estimated. If the classification of Cryptogams is, at the present monent, in a more satisfactory position than that of Phanerogams, it is just because the study of the former group has been, for various reasons, more thorough and more minute than that of the latter.

PALEOPHYTOLOGY.

The stimulating influence of the new doctrine was not, however, confined to the investigation of existing plants; it also gave a remarkable impulse to the study of fossil plants, inasmuch as the theory of descent involves the quest of the ancestors of the forms that we now have around us. Marvelous progress has been made in this direction during the nineteenth century, by the labors more especially of Brongniart, Goeppert, Unger, Schimper, Schenck, Saporta, Solms-Laubach, Renault, on the Continent, and in our own country of Lindley and Hutton, Hooker, Carruthers, and more especially of Williamson. So far-reaching are the results obtained that I can only attempt the barest summary of them. I may perhaps best begin by saying that only a small proportion of existing species have been found in the fossil state. In illustration I may adduce the statement made by Mr. Clement Reid in his recent work, 'The Origin of the British Flora,' that only 270 species that is, about one-sixth of the total number of British vascular plants, are known as fossils. Making all due allowances for the imperfection of the geological record, for the limited area investigated, and for the difficulty of determination of fragmentary specimens, it may be stated generally that the number of existing species has been found to rapidly diminish in the floras of successively older strata; none, in fact, has been certainly found to persist beyond the Tertiary period. Certain existing genera, belonging to the Gymnosperms and to the Pteridophyta, have, however, been traced far down into the Mesozoic period. Similarly, the distribution in time of existing natural orders does not coincide with that of existing genera; thus the Ferns of the Carboniferous epoch apparently belong, for the most part, if not altogether, to the order Marattiaceæ, but they are not referable to any of the existing genera.

Moreover, altogether new families of fossil plants have been discovered: such are, among Gymnosperms, the Cordaitaceæ and the Bennettitaceæ; among Pteridophyta, the Calamariaceæ, the Lepidodendraceæ, the Sphenophyllaceæ and the Cycadofilices. It is of interest to note that all these newly discovered families can be included within the main subdivisions of the existing flora; in fact, no fossil plants have been found which suggest the existence in the past of groups outside the limits of our Phanerogamia, Pteridophyta, Bryophyta and Thallophyta.

It cannot be said that the study of Paleobotany has as yet made clear the ancestry and the descent of our existing flora. To begin with the angiospermous flowering plants, it has been ascertained that they make their first appearance in the Cretaceous epoch, but we have no clue as to their origin. The relatively late appearance of Angiosperms in geological time suggests that they must have sprung from an older group, such as the Gymnosperms or the Pteridophyta; but there is no evidence to definitely establish either of these possible origins. Then as to the origin of the Gymnosperms, whilst it cannot be doubted that they were derived from the Pteridophyta, the existing data are insufficient to enable us to trace their pedigree. The most ancient family of Gymnosperms, the Cordaitaceæ, can be traced as far back as any known Pteridophyta, and cannot, therefore, have been derived from them; but the fact that the Cordaitaceæ exhibit certain cycadean affinities, and the discovery of the Cycadofilices, suggest that what may be termed the cycadean phylum of Gymnosperms (including the Cordaitaceæ, Bennettitaceæ, Cycadaceæ, and perhaps the Ginkgoaceæ) had its origin in a filicineous ancestry, of which, it must be admitted, no forms have as yet been recognized.

Turning to the Pteridophyta, the origin of the Ferns is still quite unknown: the one fact which seems to be clear is that the eusporangiate forms (Marattiaceæ) are more primitive than the leptosporangiate. With regard to the Equisetinæ, the Calamariaceæ were no doubt the ancestors of the existing and of the fossil Equisetums. Similarly, in the Lycopodinæ, the paleozoic Lepidodendraceæ were the forerunners of the existing Lycopodiums and Selaginellas. The discovery of the Sphenophyllaceæ seems to throw some further light upon the phylogeny of these two groups, inasmuch as these plants possess characters which indicate affinity with both the Equisetinæ and the Lycopodinæ, thus suggesting the possibility that they may have sprung from the same ancestral stock.

To complete the geological survey of the vegetable kingdom I will briefly allude to the Bryophyta and the Thallophyta. Owing no doubt to their delicate texture, the records of these plants have been found to be very incomplete. So much is this the case with the Bryophyta that I forbear to make any statement concerning them. The chief point of interest with regard to the Fungi is that most of those which have been discovered in the fossil state were found in the tissues of woody plants on which they were parasitic. In this way it has been possible to ascertain, with some probability, the existence of Bacteria and of mycelial Fungi in the Paleozoic period. The records of the Algæ are more satisfactory; they have been traced far back into the Paleozoic age, where they are represented by siphonaceous forms and by the somewhat obscure plants known as *Nematophycus* and *Pachytheca*.

In a general way the study of Paleobotany has proved the development of higher from lower forms in the successive geological periods. Thus the Tertiary and Quaternary periods are characterized by the predominance of Angiosperms, just as the Mesozoic period is characterized by the predominance of Gymnosperms, and the Paleozoic by the predominance of Pteridophyta. And yet, as I have been pointing out, we are not able to trace the ancestry of any one of the larger groups of plants. The chief reason for this is that the geological record, so far as it is known, has been found to break off with such surprising abruptness that the earliest, and, therefore, the most interesting, chapters in the evolution of plants are closed to us. After the wealth of plant-forms in the Carboniferous epoch there is a striking falling-off in the Devonian, in which, however, plants of high organization, such as the Cordaitaceæ, the Calamariaceæ and the Lepidodendraceæ, still occur. In the Silurian epoch vascular plants are but sparingly present—but it is remarkable that any such highly organized plants should be found there —together with probable Algæ, such as *Nematophycus* and *Pachytheca*. The Cambrian rocks present nothing but so-called 'Fucoids,' such as *Eophyton*, etc., some of which may be Algæ. The only known fossil in the oldest strata of all, the Archæan, is the much-discussed *Eozoon canadense*, probably of animal origin; but the occurrence here of large deposits of graphite seems to indicate the existence of a considerable flora which has, unfortunately, become quite undeterminable. Thus, whilst there is some evidence that the primitive plants were Algæ, there is at present no available record of the various stages through which the Silurian and Devonian vascular plants were evolved from them.

MORPHOLOGY.

If inquiry be made as to the cause of the great advance in the recognition of the true affinities of plants, and consequently in their classification, which distinguishes the nineteenth century, I would refer it to the progress made in the study of morphology. The earlier botanists regarded all the various parts of plants as 'organs' in relation to their supposed function; hence their description of plants was simply 'organography.' The idea of regarding the parts of the plant-body, not in connection with their functions, but with reference to their development and their mutual relations, seems to have originated with Jung in the seventeenth century (1687): it was revived by C. F. Wolff about seventy years later (1759), but it did not materially affect the study of plants until well on in the nineteenth century, after Goethe had repeatedly written on the subject and had devised the term 'morphology' to designate it. For a time this somewhat abstract mode of treatment led to mere theorizing and speculation, so much so that the years 1820–1840 will always be stigmatized as the period of the 'Naturphilosophie.' But fortunately this time of barrenness was succeeded by a veritable renascence. Robert Brown and Henfrey in England; Brongniart, St. Hilaire, and Tulasne in France; Mohl, Schleiden, Naegeli, A. Braun and above all Hofmeister in Germany, led the way back from the pursuit of fantastic will-o'-the-wisps to the observation of actual fact. Instead of evolving schemes out of their own internal consciousness as to how plants ought to be constructed, they endeavored to discover by the study of development, and more particularly of embryogeny, how they actually are constructed, with the result that within a decade Hofmeister discovered the alternation of generations in the higher plants; a discovery which must ever rank as one of the most brilliant triumphs of morphological research.

With the knowledge thus acquired it became possible to determine the true relations of the various parts of the plant-body; to distinguish these parts as 'members' rather than as 'organs'; in a word, to establish homologies where hitherto only analogies had been traced—which is the essential difference between morphology and organography.

The publication of the 'Origin of Species' profoundly affected the progress of morphology, as of all branches of biological research; but it did not alter its trend; it confirmed and extended it. We are not satisfied now with establishing homologies, but we go on to inquire into the origin and phylogeny of the members of the body. In illustration I may briefly refer to two problems of this kind which at the present time are agitating the botanical world. The first is as to the origin of the alternation of generations. Did it come about by the modification of the sexual generation (gametophyte) into an asexual (sporophyte); or is the sporophyte a new formation intercalated into the life-history? In a word, is the alternation of generations to be regarded as homologous or as antithetic? I am not rash enough to express any opinion on this controversy; nor is it necessary that I should do so, since the subject has twice been threshed out at recent meetings of this Section. The second problem is as to the origin of the sporophylls, and, indeed, of all the various kinds of leaves of the sporophyte in the higher plants. It is suggested, on the one hand, that the sporophylls of the Pteridophyta have arisen by gradual sterilization and segmentation from an unsegmented and almost wholly reproductive body, represented in our day by the sporogonium of the Bryophyta; and that the vegetative leaves have been derived by further sterilization from the sporophylls. On the other hand, it is urged that the vegetative leaves are the more primitive, and that the sporophylls have been derived from them. It will be at once observed that this second problem is intimately connected with the first. The sterilization theory of the origin of leaves is a necessary consequence of the antithetic view of the alternation of generations; whilst the derivation of sporophylls from foliage-leaves is similarly associated with the homologous view. Here, again, exercising a wise discretion, I will only venture to express my appreciation of the important work which has been done in connection with this controversy—work that will be equally valuable, whatever the issue may eventually be.

I will conclude my remarks on morphology with a few illustrations of the aid which the advance in this department has given to the progress of classification. For instance, Linnæus divided plants into Phanerogams and Cryptogams, on the ground that in the former the reproductive organs and processes are conspicuous, whereas in the latter they are obscure. In view of our increased knowledge of Cryptogams, this ground of distinction is no longer tenable; whilst still recognizing the validity of the division, our reasons for doing so are altogether different. For us, Phanerogams are plants which produce a seed; Cryptogams are plants which do not produce a seed. Again, we distinguish the Pteridophyta and the Bryophyta from the Thallophyta, not on account of their more complex structure, but mainly on the ground that the alternation of generations is regular in the two former groups, whilst it is irregular or altogether wanting in the latter. Similarly the essential distinction between the Pteridophyta and the Bryophyta is that in the former the sporophyte, in the latter the gametophyte, is the preponderating form. It has enabled us further to correct in many respects the classifications of our predecessors by altering the systematic position of various genera, and sometimes of larger groups. Thus the Cycadaceæ have been removed from among the Monocotyledons, and the Coniferæ from among the Dicotyledons, where de Candolle placed them, and have been united with the Gnetaceæ into the sub-class Gymnospermæ. The investigation of the development of the flower, in which Payer led the way, and the elaboration of the floral diagram which we owe to Eichler, have done much, though by no means all, to determine the affinities of doubtful Angiosperms, especially among those previously relegated to the lumber-room of the Apetalæ.

ANATOMY AND HISTOLOGY.

Passing now to the consideration of the progress of knowledge concerning the structure of plants, the most important result to be chronicled is the discovery that the plant-body consists of living substance indistinguishable from that of which the body of animals is composed. The earlier anatomists, whilst recognizing the cellular structure of plants, had confined their attention to the examination of the cell-walls, and described the contents as a watery or mucilaginous sap, without determining where or what was the seat of life. In 1831 Robert Brown discovered the nucleus of the cell, but there is no evidence that he regarded it as living. It was not until the renascence of research in the forties, to which I have already alluded, that any real progress in this direction was made. The cell-contents were especially studied by Naegeli and by Mohl, both of whom recognized the existence of a viscous substance lining the wall of all living cells as a 'mucous layer' or 'primordial utricle,' but differing chemically from the substance of the wall by being nitrogenous: this they regarded as the living part of cell, and to it Mohl (1846) gave the name 'protoplasm,' which it still bears. The full significance of this discovery became apparent in a somewhat roundabout way. Dujardin, in 1835, had described a number of lowly organisms, which he termed Infusoria, as consisting of a living substance, which he called 'sarcode.' Fifteen years later, in a remarkable paper on *Protococcus pluvialis*, Cohn drew attention to the similarity in properties between the 'sarcode' of the Infusoria and the living substance of this plant, and arrived at the brilliant generalization that the 'protoplasm' of the botanists and the 'sarcode' of the zoologists are identical. Thus arose the great conception of the essential unity of life in all living things, which, thanks to the subsequent labors of such men as de Bary, Brücke, and Max Schultze, in the first instance, has become a fundamental canon of Biology.

A conspicuous monument of this period of activity is the cell-theory propounded by Schwann in 1839. Briefly stated, Schwann's theory was that all living bodies are built up of structural units which are the cells: each cell possesses an independent vitality, so that nutrition and growth are referable, not to the organism as a whole, but to the individual cells. This conception of the structure of plants was accepted for many years, but it has had to give way before the advance of anatomical knowledge. The recognition of cell-division as the process by which the cells are multiplied—in opposition to the Schleidenian theory of free cell-formation—early suggested doubts as to the propriety of regarding the body as being built up of cells as a wall is built of bricks. Later the minute study of the Thallophyta revealed the existence of a number of plants, such as Myxomycetes, the phycomycetous Fungi, and the siphonaceous Algæ, some of them highly organized, the vegetative body of which does not consist of cells. It became clear that cellular structure is not essential to life; that it may be altogether absent or present in various degree. Thus in the higher plants the protoplasm is segmented or septated by walls into uninucleate units or 'energids' (Sachs), and such plants are well described as 'completely septate.' But in others, such as the higher Fungi and certain Algæ (*e. g.*, *Cladophora*, *Hydrodictyon*), the protoplasm is septated, not into energids, but into groups of energids, so that the body is 'incompletely septate.' Finally there are the Thallophyta already enumerated, in which there is complete continuity of the protoplasm: these are 'unseptate.' Moreover, even when the body presents the most complete cellular structure, the energids are not isolated, but are connected by delicate protoplasmic fibrils traversing the intervening walls; a fact which is one of the most striking discoveries in the department of histology. This was first recognized in the sieve-tubes by Hartig (1837); then by Naegeli (1846) in the tissues of the Florideæ. After a long period of neglect the matter was taken up once more by Tangi (1880), when it attracted the attention of many investigators, as the result of whose labors, especially those of Mr. Gardiner, the general and perhaps universal continuity of the protoplasm in cellular plants has been established. Hence the body is no longer regarded as an aggregate of cells, but as a more or less septated mass of protoplasm: the synthetic standpoint of Schwann has been replaced by one as distinctively analytic.

Time does not permit me to do more than mention the important discoveries made of late years, mainly on the initiative of Strasburger, with regard to the details of cytology, and especially to the structure of the nucleus and the intricate dance of the chromosomes in karyokinesis. Indeed, I can do but scant justice to those anatomical discoveries which are of more exclusively botanical interest. One important generalization which may be drawn is that the histological differentiation of the plant proceeds, not in the protoplasm, as in the animal, but in the cell-wall. It is remarkable, on the one hand, how similar the protoplasm is, not only in different parts of the same body, but in plants of widely different affinities; and, on the other, what diversity the cell-wall offers in thickness, chemical composition, and physical properties. In studying the differentiation of the cell-wall the botanist has received valuable aid from the chemist. Research in this direction may, in fact, be said to have begun with Payen's fundamental discovery (1844) that the characteristic and primary chemical constituent of the cell-wall is the carbohydrate which he termed cellulose.

The amount of detailed knowledge as to the anatomy of plants which has been accumulated during the century by countless workers, among whom Mohl, Naegeli, Unger, and Sanio deserve special mention as pioneers, is very great—so great, indeed, that it seemed as if it must remain a mere mass of facts in the absence of any recognizable general principles which might serve to marshal the facts into a science. The first step towards a morphology of the tissues was Hanstein's investigation of the growing point of the Phanerogams (1868), and his recognition therein of the three embryonic tissue-systems. This has lately been further developed by the promulgation of van Tieghem's theory of the stele, which is merely the logical outcome of Hanstein's distinction of the plerome. It has thus become possible to determine the homologies of the tissue-systems in different plants and to organize the facts of structure into a scientific comparative anatomy. It has become apparent that, in many cases, differences of structure are immediately traceable to the influence of the environment; in fact, the study of physiological or adaptive anatomy is now a large and important branch of the subject.

The study of Anatomy has contributed in some degree to the progress of systematic Botany. It is true that some of the more ambitious attempts to base classification on Anatomy have not been successful; such, for instance, as de Candolle's subdivision of Phanerogams into Exogens and Endogens, or the subdivision of Cormophyta into Acrobrya, Amphibrya, and Acramphibrya, proposed by Unger and Endlicher. Still it cannot be denied that anatomical characters have been found useful, if not absolutely conclusive, in suggesting affinities, especially in the determination of fossil remains. A large proportion of our knowledge of extinct plants, to which I have already alluded, is based solely upon the anatomical structure of the vegetative organs; and although affinities inferred from such evidence cannot be regarded as final, they suffice for a provisional classification until they are confirmed or disproved by the discovery and investigation of the reproductive organs.

PHYSIOLOGY.

The last branch of the botanical science which I propose to pass in review is that of physiology. We may well begin with the nutritive processes. At the close of the eighteenth century there was practically no coherent theory of nutrition; such as it was it amounted to little more than the conclusion arrived at by van Helmont a century and a half earlier, that plants require only water for their food, and are able to form from it all the different constituents of their bodies. It is true that the important discovery had been made and pursued by Priestley (1772), Ingen-Housz (1780), and Sénébier (1782) that green plants exposed to light absorb carbon dioxide and evolve free oxygen; but this gaseous interchange had not been shown to be the expression of a nutritive process. At the opening of the nineteenth century (1804) this connection was established by de Saussure, in his classical 'Recherches chimiques,' who demonstrated that, whilst absorbing carbon dioxide and evolving oxygen, green plants gain in dry weight; and he further contributed to the elucidation of the problem of nutrition by showing that, whilst assimilating carbon dioxide, green plants also assimilate the hydrogen and oxygen of water.

Three questions naturally arose in connection with de Saussure's statement of the case: What is the nature of the organic substance formed? What is the function of the chlorophyll? What is the part played by light? It was far on in the century before answers were forthcoming.

With regard to the first of these questions, the researches of Boussingault (1864) and others established the fact that the volume of carbon dioxide absorbed and that of oxygen evolved in connection with the process are approximately equal. Further, the frequent presence of starch in the chloroplastids, to which Mohl first drew attention (1837), was subsequently found by Sachs (1862) to be closely connected with the assimilation of carbon dioxide. The conclusion drawn from these facts is that the gain in dry weight accompanying the assimilation of carbon dioxide is due to the formation, in the first instance, of organic substance having the composition of a carbohydrate; a conclusion which may be expressed by the equation:

$$CO_2 + H_2O = CH_2O + O_2.$$

The questions with regard to chlorophyll and to light are so intimately connected that they must be considered together. The first step towards their solution was the investigation of the relative activity of light of different colors, originally undertaken by Sénébier (1782) and subsequently repeated by Daubeny (1836), with the result that red and orange light was found to promote assimilation in a higher degree than blue or violet light. Shortly afterwards Draper (1843), experimenting with an actual solar spectrum, concluded that the most active rays are the orange and yellow; a conclusion which was generally accepted for many years. But in the meantime the properties of the green coloring matter of plants (to which Pelletier and Caventou gave the name 'chlorophyll' in 1817) were being investigated. Brewster discovered in 1834 that an alcoholic extract of green leaves presents a characteristic absorption spectrum; but many years elapsed before any attempt was made to connect this property with the physiological activity of chlorophyll. It was not until 1871–72 that Lommel and N. J. C. Müller pointed out that the rays of the spectrum which are most completely absorbed by chlorophyll are just those which are most efficient in the assimilation of carbon dioxide. Subsequent researches, particularly those of Timiriazeff (1877), and those of Engelmann (1882–84) based on his ingenious Bacterium-method, have confirmed the views of Lommel and of Müller, and have placed it beyond doubt that the importance of light in the assimilatory process is that it is the form of kinetic energy necessary to effect the chemical changes, and that the function of chlorophyll is to serve as the means of absorbing this energy and of making it available for the plant.

These are perhaps the most striking discoveries in relation to the nutrition of plants, but there are others of not less importance to which brief allusion must be made. We owe to de Saussure (1804) the first clear demonstration of the fact that plants derive an important part of their food from the soil; but the relative nutritive value of the inorganic salts absorbed in solution was not ascertained until Sachs (1858) reintroduced the method of water-culture which had originated centuries before with Woodward (1699) and had been practiced by Duhamel (1768) and de Saussure. Special interest centers around the question of the nitrogenous nutrition of plants. It was long held, chiefly on the authority of Priestley and of Ingen-Housz, and in spite of the contrary opinion expressed by Sénébier, Woodhouse (1803), and de Saussure, that plants absorb the free nitrogen of the atmosphere by their leaves. This view was not finally abandoned until 1860, when the researches of Boussingault and of Lawes and Gilbert deprived it of all foundation. Since then we have learned that the free nitrogen of the air can be made available for nutrition—not indeed directly by green plants themselves, but, as Berthelot and Winogradsky more especially have shown, by Bacteria in the soil, or, as apparently in the Leguminosæ, by Bacteria actually enclosed in the roots of the plants with which they live symbiotically.

We turn now from the nutritive or anabolic processes to those which are catabolic. The discovery of the latter, just as of the former, was arrived at by the investigation of the gaseous interchange between the plant and the atmosphere. In the eighteenth century Scheele and Priestley had found that, under certain circumstances, plants deteriorate the quality of air; but it is to Ingen-Housz that we owe the discovery that plants, like animals, respire, taking in oxygen and giving off carbon dioxide. And when Sénébier (1800) had ascertained for the inflorescence of *Arum maculatum*, and later de Saussure (1822) for other flowers, that active respiration is associated with an evolution of heat, the connection between respiration and catabolism was established for plants as it had been long before by Lavoisier (1777) in the case of animals.

Among the catabolic processes which have been investigated none are of greater importance than those that are designated by the general term *fermentations*. The first of these to be discovered was the alcoholic fermentation of sugar. Towards the end of the seventeenth century Leeuwenhoek had detected minute globules in fermenting wort; and a century later Lavoisier had ascertained that the chemical process consists in the decomposition of sugar into alcohol and carbon dioxide; but it was not until 1837–38 that, almost simultaneously, Cagniard de Lateur, Schwann, and Kützing discovered that Leeuwenhoek's globules were living organisms, and were the cause of the fermentation. Shortly before, in 1833, Payen and Persoz extracted from malt a substance named *diastase*, which they found could convert the starch of the grain into sugar. These two classes of bodies, causing fermentative changes, were distinguished respectively as *organized* and *unorganized* ferments. The number of the former was rapidly added to by the investigation more especially of the Bacteria, in which Pasteur led the way. The extension of our knowledge of the unorganized ferments, or enzymes, has been even more remarkable: we now know that very many of the metabolic processes are effected by various enzymes, such as those which convert the more complex carbohydrates into others of simpler constitution (diastase, cytase, glucase, inulase, invertase); those which decompose glucosides (emulsin, myrosin, etc.); those which act on proteids (trypsins) and on fats (lipases); the oxidases, which cause the oxidation of various organic substances; and the zymase, recently extracted from yeast, which causes alcoholic fermentation.

The old distinction of the microorganisms as 'organized ferments' is no longer tenable; for, on the one hand, certain of the chemical changes which they effect can be traced to extractable enzymes which they produce; and, on the other, as Pasteur has asserted, every living cell may become an 'organized ferment' under appropriate conditions. The distinction now to be drawn is between those processes which are due to enzymes and those directly effected by living protoplasm. Many now definitely included in the former class were, until lately, regarded as belonging to the latter; and no doubt future investigation will still further increase the number of the former at the expense of the latter.

The consideration of the metabolic processes leads naturally to that of the function of transpiration and of the means by which water and substances in solution are distributed in the plant. This is perhaps the department of physiology in which progress during the nineteenth century has been least marked. We have got rid, it is true, of the old idea of an ascending crude sap and of a descending elaborated sap, but there have been no fundamental discoveries. With regard to transpiration itself, we know more of the detail of the process, but that is all that can be said. As for root-pressure, Hofmeister (1858–82) discovered that 'bleeding'—as the phenomena of root-pressure were termed by the earlier writers—is not confined, as had hitherto been thought, to trees and shrubs; but the current theory of the process, allowing for the discovery of protoplasm and of osmosis, has advanced but little upon that given by Grew in the third book of his 'Anatomy of Plants' (1675). Again, the mechanism of the transpiration-current in lofty trees remains an unsolved problem. To begin with, there is still some doubt as to the exact channel in which the current travels. Knight (1801–8) first proved that the current travels in the alburnum of the trunk, but not, he thought, in the vessels, for he found them to be dry in the summer, when transpiration is most active; a view in which Dutrochet (1837) subsequently concurred. Meyen (1838) then suggested that the water must travel, not in the lumina, but in the substance of the cells of the vessels, and was supported by such eminent physiologists as Hofmeister (1858), Unger (1864, 1868), and Sachs (1878); but it has since been strongly asserted by Boehm, Elfving, Vesque, Hartig, and Strasburger that the young vessels always contain water, and that the current travels in the lumina and not in the walls of the vessels.

Now as to the force by which the water of the transpiration-current is raised from the roots to the topmost leaf of a lofty tree. From the point of view that the water travels in the substance of the walls, the necessary force need not be great, and would be amply provided by the transpiration of the leaves, inasmuch as the weight of the water raised would be supported by the force of imbibition of the walls. From the point of view that the water travels in the lumina, the force required to raise and support such long columns of water must be considerable. Dismissing at once as quite inadequate such purely physical theories as those of capillarity and gas-pressure, there remain two theories as to the nature of this force which resemble each other in being essentially vitalistic, but differ in that the one involves pressure from below, and the other suction from above. In the one, suggested by Godlewski and by Westermaier (1884), the cells of the medullary rays and of the wood-parenchyma are supposed to absorb liquid from the vascular tissue at one level and force it back again by a vital act at a higher level: this theory was disposed of by the fact that the transpiration-current can be maintained through a considerable length of a stem killed by heat or by poison. In the other, suggested by Dixon and Joly (1895–99), and also by Askenasy (1895–96), it is assumed that there are, in the trunk of a transpiring tree, continuous columns of water which are in a state of tensile stress, the tension being set up by the vital transpiratory activity of the leaves. Some idea of the enormous tension thus assumed is given by the following simple calculation relating to a tree 120 feet high. Not only has the liquid to be raised to this height, but in its passage upwards a resistance calculated to be equal to about five times the height of the tree has to be overcome. Hence the transpiration-force in such a tree must at least equal the weight of a column of water 720 feet in height; that is, a pressure of about twenty-four atmospheres, or 360 lbs. to the square inch. But there is no evidence to prove that a tension of anything like twenty atmospheres exists, as a matter of fact, in a transpiring tree; on the contrary, such observations as exist (*e. g.*, those of Hales and Boehm) indicate much lower tensions. Under these circumstances we must regretfully confess that yet one more century has closed without bringing the solution of the secular problem of the ascent of the sap.

The nineteenth century has been, fortunately, more fertile in discovery concerning the movements and irritability of plants. But it is surprising how much knowledge on these points had been accumulated by the beginning of the century: the facts of plant-movement, such as the curvatures due to the action of light, the sleep-movements of leaves and flowers, the contact-movements of the leaves of the sensitives, were all familiar. The nineteenth century opened, then, with a considerable store of facts; but what was lacking was an interpretation of them; and whilst it has largely added to the store, its most important work has been done in the direction of explanation.

The first event of importance was the discovery by Knight, in 1806, of the fact that the stems and roots of plants are irritable to the action of gravity and respond to it by assuming definite directions of growth. Many years later the term 'geotropism' was introduced by Frank (1868) to designate the phenomena of growth as affected by gravity, and at the same time Frank announced the important discovery that dorsiventral members, such as leaves, behave quite differently from radial members, such as stems and roots, in that they are diageotropic.

It was a long time before the irritability of plants to the action of light was recognized. Chiefly on the authority of de Candolle (to whom we owe the term 'heliotropism'), heliotropic curvature was accounted for by assuming that the one side received less light than the other, and therefore grew the more rapidly. But the researches of Sachs (1873) and Müller-Thurgau (1876) have made it clear that the direction of the incident rays is the important point, and that a radial stem, obliquely illuminated, is stimulated to curve until its long axis coincides with the incident rays. Moreover, the discovery by Knight (1812) of negative heliotropism in the tendrils of *Vitis* and *Ampelopsis* really put the Candollean theory quite out of court; and further evidence that heliotropic movements are a response to the stimulus of the incident rays of light is afforded by Frank's discovery of the diaheliotropism of dorsiventral members.

The question of the localization of irritability has received a good deal of attention. The fact that the under surface of the pulvinus of *Mimosa pudica* is alone sensitive to contact was ascertained by Burnett and Mayo in 1827; and shortly after (1834) Curtis discovered the sensitiveness of the hairs on the upper surface of the leaf of *Dionæa*. After a long period of neglect the subject was taken up by Darwin. The irritability of tendrils to contact had been discovered by Mohl in 1827; but it was Darwin who ascertained, in 1865, that it is confined to the concavity near the tip. In 1875 Darwin found that the irritability of the tentacles of *Drosera* is localized in the terminal gland; and followed this up, in 1880, by asserting that the sensitiveness of the root is localized in the tip, which acts like a brain. This assertion led to a great deal of controversy, but the researches of Pfeffer and Czapek (1894) have finally established the correctness of Darwin's conclusion. It is interesting to recall that Erasmus Darwin had suggested the possible existence of a brain in plants in his 'Phytologia' (1800). But the word 'brain' is misleading, inasmuch as it might imply sensation and consciousness: it would be more accurate to speak of centers of ganglionic activity. However, the fact remains that there exist in plants irritable centers which not only receive stimuli but transmit impulses to those parts by which the consequent movement is effected. The transmission of stimuli has been found in the case of *Mimosa pudica* to be due to the propagation of a disturbance of hydrostatic equilibrium along a special tissue; in other cases, where the distance to be traversed is small, it is probably effected by means of that continuity of the protoplasm to which I have already alluded.

Finally, as regards the mechanism of these movements, we find Sénébier and Rudolphi, the earliest writers on the subject in the nineteenth century, asserting, as if against some accepted view, that there is no structure in a plant comparable with the muscle of an animal. Rudolphi (1807) suggested, as an alternative, that the position of a mobile leaf is determined by the 'turgor vitalis' of the pulvinus, and thus anticipated the modern theory of the mechanism. But he gives no explanation of what he means by 'turgor'; and the term is frequently used by writers in the first half of the century in the same vague way. Some progress was made in consequence of the discovery of osmosis by Dutrochet (1828), and more especially by his observation (1837) that the movements of *Mimosa* are dependent on the presence of oxygen, and are therefore vital. But it was not, and could not be, until the existence of living protoplasm in the cells of plants was realized, and the movements of free-swimming organisms and naked reproductive cells had become more familiar, that the true nature of the mechanism began to be understood; and then we find Cohn saying, as long ago as 1860, that 'the living protoplasmic substance is the essentially contractile portion of the cell.' This statement may, perhaps, seem to put the case too bluntly and savor too much of animal analogy; but the study of the conditions of turgidity has shown more and more clearly that the protoplasm is the predominant factor. The protoplasm of plant-cells is undoubtedly capable of rapid molecular changes, which alter its physical properties, more particularly its permeability to the cell-sap. It may be that these changes cannot be directly compared with those going on in animal muscle; but if we use the term 'contractility' in its wider sense, as indicating a general property of which muscular contraction is a special case, then Cohn's statement is fully justified. This is borne out by the observations of Sir J. Burdon-Sanderson (1882–88) on the electrical changes taking place in the stimulated leaf of *Dionæa*, and by Kunkel's (1878) corresponding observations on *Mimosa publica*: in both cases the electrical changes were found to be essentially the same as those observable on the stimulation of muscle. We find, then, that the advances in Physiology, like those in Anatomy, teach the essential unity of life in all living things, whether we call them animals or plants.

With this in our minds we may go on to consider in conclusion, and very briefly, that department of physiological study which is known as the Bionomics or Œcology of plants. In the earlier part of the century this subject was studied more especially with regard to the distribution of plants, and their relation to soil and climate; but since the publication of the 'Origin of Species' the purview has been greatly extended. It then became necessary to study the relation of plants, not only to inorganic conditions, but to each other and to animals; in a word, to study all the adaptations of the plant with reference to the struggle for existence. The result has been the accumulation of a vast amount of most interesting information. For instance, we are now fairly well acquainted with the adaptations of water-plants (hydrophytes) on the one hand and of desert-plants (xerophytes) on the other; with the adaptations of shade-plants and of those growing in full sun, especially as regards the protection of the chlorophyll. We have learned a great deal as to the relations of plants to each other, such as the peculiarities of parasites, epiphytes, and climbing plants, and as to those singular symbioses (Mycorhiza) of the higher plants with Fungi which have been found to be characteristic of saprophytes. Then, again, as to the relations between plants and animals: the adaptation of flowers to attract the visits of insects, first discovered by Sprengel (1793), has been widely studied; the protection of the plant against the attacks of animals, by means of thorns and spines on the surface, as also by the formation in its tissues of poisonous or distasteful substances, and even by the hiring of an army of mercenaries in the form of ants, has been elucidated; and finally those cases in which the plant turns the tables upon the animal, and captures and digests him, are now fully understood.

CONCLUSION.

Imperfect as is the sketch which I have now completed, it will, I think, suffice to show how remarkable has been the progress of the science during the nineteenth century, more particularly the latter part of it, and how multifarious are the directions in which it has developed. In fact Botany can no longer be regarded as a single science: it has grown and branched into a congeries of sciences. And as we botanists regard with complacency the flourishing condition of the science whose servants we are, let us not forget, on the one hand, to do honor to those whose life work it was to make the way straight for us, and whose conquests have become our peaceful possession; nor, on the other, that it lies with us so to carry on the good work that when this Section meets a hundred years hence it may be found that the achievements of the twentieth century do not lag behind those of the nineteenth.

S. H. VINES.

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*THE METHOD OF TYPES IN BOTANICAL NOMENCLATURE.**

FOR many decades the systematic botany of the United States can scarcely be said to have had a history separate from that of Europe, so extensively were our treasures exploited by transient visitors, while resident students of the science long remained

* Read at the New York meeting of the Botanical Club of the A. A. A. S., through the kindness of Mr. Charles Louis Pollard. On motion the paper was referred to the Committee on Nomenclature and the author was requested to offer it for publication in SCIENCE.

dependent upon European patrons and correspondents. But even after a considerable independent development had been reached in this country, botany remained centralized to the extent that the writings of a very few masters constituted a large percentage of the published output of the science, and scarcely less in America than in England was the taxonomic side dominated by the spirit and methods of the brilliant coterie of Kew systematists. It was inevitable, however, with the spread of scientific knowledge and the quickening of interest in biological subjects, that the time should come when systematic activity could be confined no longer to a few herbaria, when botany like other sciences must be decentralized. Though this fact has been deplored, especially by those who had enjoyed a more or less complete monopoly of opportunity, it must be admitted that scientific study is one of the natural rights of man about which no artificial barriers can be maintained. Moreover, systematic botany reached a stage when it became evident that the last word could not be spoken from the herbarium, and that the results of local field study are legitimate subjects for record and publication. As long as a few men contented themselves with the issue of a few large treatises per decade, inequalities in their taxonomic views or methods of nomenclature caused comparatively little difficulty, each generation following without serious confusion the recognized authority of its time. But as workers multiplied, the annoyances of contemporary differences became so great that the desire for uniformity gradually crystallized into a movement for the formulation of a rational code of nomenclature by which all might be guided.

As often happens in reform movements, a single issue became prominent, and attention was chiefly directed to the correction of what had come to be regarded as a flagrant and unreasonable abuse of the power of arbitrary change of names. The proposition known as the 'Kew Rule,' to the effect that a species might be renamed whenever transferred to another genus was emphatically negatived in the interest of a consistent application of the principle of priority. This does not mean that such a rule was essentially illogical, any more than was the other custom of eighteenth century botanists who set aside by wholesale the genera of their predecessors, substituting their own improved concepts and more euphonious names. Neither was the changing of specific names anything new; it had been customary throughout the history of systematic botany, but the time had passed when the scientific public could be trifled with, even by the specialist sure of the finality of his own conclusions.

In spite of minor features which still seem objectionable to many botanists, such as the supplanting of specific names by varietal, and the use of duplicate binomials, the 'Rochester Rules' have proved to be a most valuable piece of progressive legislation, the general wisdom and logical authority of which it is not necessary to question. At the same time it is unfortunate that many seem to have expected the new code to be final and perfect, even in matters which did not come before the minds of those who prepared it, but a disappointment in this regard should be no real hindrance to the consideration of other possible improvements in nomenclatorial procedure. Such finality of creeds is scarcely to be expected in progessive sciences, notwithstanding the eminent desirability of permanence and uniformity. The Rochester Code affirms the supremacy of the principle of priority and provides for its universal application in the nomenclature of species. The successful initiation and satisfactory progress of this measure but makes plainer the need of a similarly salutary regulation for determining the application and precedence of generic names. Although sometimes believed to have been adequately dealt with, this question was only indirectly touched upon by the Rochester Rules, which simply re-enacted by implication the generally neglected provisions of the Paris Code of 1867. This legislation can no longer be considered authoritative, since it was based on the pre-Darwinian doctrine that species are special creations and that the categories of classification are mere mental concepts, instead of groups of individuals having a common origin and phylogenetic relationships. As a concept, there is no particular reason why a genus should not be emended, subdivided or set aside entirely if found erroneous, but as a group of related species for which a permanent common name is desired, the genus should no longer be treated by the formal or conceptual method. Obviously, it is far more important, as well as more scientific and more practical, that a part of organized nature have a fixed designation than that naturalists continue to waste their energy in investigating the applicability and adjusting the claims of the varied succession of rival concepts. Although to many the genus appears to be less tangible than the species, it is possible to guarantee to it the permanence and stability now enjoyed by the species under the Rochester Code. By considering a single species the nomenclatorial type of its genus, to which the name is to remain inseparably attached, we place upon firm ground and solidify to the point of general tangibility and comprehension the misty fabric of conceptual classification.

At the Springfield meeting of the Botanical Club where the legislation begun at Rochester was concluded by the acceptance of the report of the Nomenclature Committee, an attempt was made to secure attention for this matter of definite priority for genera by the recognition of a method of fixing the types. The necessity of some such procedure in carrying out a satisfactory revision of at least one group of organisms was explained in a paper entitled 'Personal Nomenclature in the Myxomycetes.'*

It appeared, however, that those who had been most zealous for the reform of specific nomenclature had not the same appreciation of the problems of generic taxonomy, perhaps because the illogical and unstable results of the method of concepts are less obvious in dealing with the higher plants, and especially with the European and North American floras in which the species of the older writers are nearly always identifiable, at least to the extent of determining their generic relationships. It is thus usually *possible* to apply the so-called method of residues or elimination under which the type species or a genus are held to be those of the original complement which have not been removed. But by this rule it is often quite impossible to fix the application of a generic name to one group of species when several were enumerated under the generic name at its first appearance. Thus if the three original species of a genus are found to belong to as many natural groups the decision as to which shall have the use of the name often depends, in final analysis, not upon anything which can be learned by consulting the original or subsequent descriptions, or even the type specimens, but

*Subsequently published in the *Bulletin of the Torrey Botanical Club*, Oct. 1895, xxii, 431–434. The present and related questions of taxonomy have also been discussed under these titles: 'Stability in Generic Nomenclature,' Science, Aug. 12, 1898, viii, 186–190, 'The Method of Types,' Science, Oct. 14, 1898, viii, 513–516, and 'Four Categories of Species,' *American Naturalist*, April, 1899, xxxiii, 287–297. In his 'Review of the Genera of Ferns proposed prior to 1832,' *Memoirs of the Torrey Botanical Club*, Dec. 1899, vi, 247–283, Professor Underwood has restated and applied the method of types, with exceptions required by the present limitations of the Rochester Rules.

upon the present monographer's views as to the relationship of the species with others included under other concepts named by writers previous or subsequent to the date of the genus under investigation. Thus, to take a very simple case, if there were a genus *A* described in 1830 with three species of which *a* is nearest related to *d*, of genus *B*, 1840, *b* is nearest related to *e*, of genus *C*, 1820, while *c* is nearest related to *f*, of genus *D*, 1850, we have already under the method of elimination a series of varying alternatives:

1. If the genera *B* and *C* be deemed valid, *D* cannot be separated, but is considered synonymous with *A*.

2. The systematist who decides that *B* is invalid applies *A* to *a* and *d* and may recognize *D* as a good genus.

3. If *C* be treated as invalid *A* may be applied to *b* and *e*, *B* and *D* being considered good.

Thus while it may be theoretically possible for a monographer to arrange to his own satisfaction the relations of the different genera, a change of taxonomic opinion affects not only the supposed limits of the genera but may *necessitate* a totally different application of the name *A* to any one of the three groups of species. And when we reflect that the complications are increased in almost geometrical ratio when the species are more numerous and when the question of the validity of *B*, *C* or *D* may be subject to equally great complications from other aspects of their real or supposed relationships, it becomes evident that the conceptual method of elimination involves an endless chain of casuistry, and is a counsel of darkness and confusion rather than of stability and perspicacity. Moreover, in the lower plants and animals the large composite genera of the earlier writers are in many cases now distributed, not merely to different families, but even to different orders and classes, so that the elucidation of some of the more difficult cases of residual taxonomy would require months of unprofitable labor in different parts of the biological field, and yet the conclusions could have only individual sanction, no steps in the process being secure with the exception of those which deal with genera described as monotypic. The designation of type species by a simple and uniform method would, however, render the application of all generic names equally definite, and would largely eliminate the personal equations which have thus far added immeasurably to the labor of biologic taxonomy, and which continue to hamper all efforts to popularize the science.

Although, as previously noted, the Rochester Rules gave a tacit adherence to the method of elimination, the case is not, in reality, that of supplanting one method of procedure by another, since with the possible exception of a small proportion of the flowering plants the method of elimination has never been consistently applied in any part of the botanical series. Most botanists, Continental, English and American, have continued to deal with genera in a manner purely personal and arbitrary. Seldom has there been any formal recognition of a type much less the choice of one by any fixed rule. Genera have often been deprived of all their original species and made to do duty for an entirely new set, with or without modification of the original description.

The conditions obtaining in the earlier genera of ferns have been investigated by Professor Underwood, and found to be much the same as in the Myxomycetes and Fungi, while a brief excursion among the palms reveals the persistence there of the spirit of lawlessness. The genus *Oreodoxa*, for example, was based on two species, one of which is now placed in *Euterpe*, and the other in *Catoblastus*, while the name *Oreodoxa* has been applied without warrant to the royal palm and its allies, which have never been designated by a correct generic name,* whether the difficulty be adjusted by the method of elimination or by the method of types. Of course it is not necessary that the types of phanerogams should be fixed by the same method as in the other groups, but all phanerogamists are not likely to remain contented with an illogical and faulty method, and it is scarcely to be expected that the Committee on Types appointed at the Buffalo meeting, will bring in recommendations for a variety of usage in a matter of so much importance.

In the incorporation of the desired legislation into the Rochester Code a large variety of courses might be followed, but for present purposes it may be sufficient to point out that these lie between two general policies, either of which may be developed in such form as to be both logical and practical. If we adhere strictly to the binomial system, to 1753, and to the '*Species Plantarum*,' we must reconcile ourselves to the misapplication of the pre-Linnæan names or treat them as exceptions and provide for the assignment of types by a committee or a congress, thus disposing at once of many bibliographic complications. This would be in accordance with the argument advanced by some of the advocates of the Rochester Code, that the process of revision of cryptogamic as well as of phanerogamic genera would be greatly simplified by relief from the incubus of the pre-Linnæan and non-binomial literature, an expectation which undoubtedly influenced many in favor of that legislation. It transpired, however, that instead of adhering to the logical consequences of the adoption of a nomenclature of genera and species based on the binomial system with the '*Species Plantarum*' as a starting point, the very committee which had framed the rules fell into the practice of interpreting Linnæus through the works of his predecessors instead of establishing the usage and identifications of his followers, thus rendering the date 1753 merely an arbitrary limit for citations, and virtually abandoning all the advantages which might have been secured by a consistent adherence to the original import of the Rochester Code, as far as it affected the taxonomy of genera. Moreover, in addition to the re-introduction of this complication, there was unearthed a large body of irrelevant, non-binomial literature issued subsequent to 1753, much of which had rested in merited oblivion for upward of a century. To accept as taxonomic literature such writings as those of Adanson, while refusing to cite Tournefort and Micheli, destroys every rational or practical effect of the intended reform and reduces the result of the Rochester legislation, as far as genera are concerned, to the empty absurdity of requiring the false citation of Linnæus and Adanson as the authors of genera which they knew only as compilers from the works of older and better botanists.

It is plain, therefore, that any argument which might have been drawn from the fact of previous legislation, if it had been logically carried out in this respect, has been lost by the apparently unconscious surrender of the Rochester Code reformers to Professor Greene's contention for the recognition of the pre-Linnæan authors, and we may thus without prejudice consider the second of the available alternatives for the enactment of a law for fixing generic names by types. To abandon 1753 as the initial date for generic nomenclature is but frankly to admit what is already an accomplished fact, and to cease to quote Linnæus, Adanson and others as the authors

*A new genus *Roystonea* is proposed, differing from *Oreodoxa* in the solitary growth, the double spathe and other characters. The type is *R. regia* (HBK), Nov. Gen. et Sp. 1 : 305, originally described from Cuba.

of genera which they did not discover. Such a step need not, however, compel us to return to the Middle Ages or to Classical Antiquity; Tournefort's '*Institutiones*' published at the appropriate date 1700 was an important integration of previous knowledge, and has long been considered the beginning of modern botanical literature; beyond this our taxonomy scarcely needs go to. Commencing with the 'Father of Genera' the selection of the first species as the type would result in no complications by reason of the Linnæan arrangement of species, and it may be confidently expected that the uniform application of such a rule would necessitate far fewer changes than would the method of elimination, whereby the doubtful or unidentifiable species are often the only residue on which time-honored names could be maintained.

To many who have desired to minimize as far as possible the bibliographic labor which is so great a burden to systematic botany, the adoption of such a change will be a matter of regret, but this argument cannot be used by the authors of the 'Check List' and other publications prepared on the basis of the Rochester Rules, since these have cheerfully assumed the burdens and multiplied the changes which a closer adherence to the binomial system would have avoided. And yet the task is quite finite, especially since we should be under no obligation to attempt the re-identification of the pre-Linnæan species, but may infer most of them with historical warrant from the citations of '*Species Plantarum*' and subsequent binomial literature.

Choice lies thus between the restriction of taxonomic recognition to genera provided with a binomial species in '*Species Plantarum*' or some subsequent work, or the admission of the genera of Tournefort and his successors whenever referable to an identifiable species, whether binomial or not. While it is true that these alternatives could be combined or modified in a variety of ways, such compromises could result only in exceptions and complications which experience has shown to be held in small favor by those who do not oppose change merely from motives of inertia.

A justification for a *laissez faire* policy in nomenclature is often based on the allegation that since the species and other categories of classification cannot be accurately defined and equalized there is no possibility of the attainment of either uniformity or stability in the use of names. Whatever may have been the justice or the logical propriety of this destructive criticism as applied to a taxonomic system based on the method of concepts, it is purely specious and ineffective with reference to the method of types. The species is a group of individuals, the genus a group of species, the family a group of genera, and these terms are quite as definite and comprehensible as other collective nouns. Botanists may never agree on the number of species, or on the number of groups of species which should be recognized as genera, but it is entirely possible for them to agree on the names as far as they agree on the groups, not by deferring to arbitrary authority, but by adherence to a rational and uniform course of procedure. As long as a genus is viewed as a concept, it belongs, obviously, where it fits best, and it is quite logical to reject it if no correspondence in nature be found, or to move it along to new series of species, where the description is more applicable than to those for which it was drawn. The conceptual theory of taxonomy comported entirely with the doctrine of special creation, but it is not adapted to the purposes of phylogenetic classification as an integration of the results of the study of the evolution of organic types, and its continued use is now unscientific as well as unpractical. As the genus does not consist of a concept, neither can it become adequately known to us through the medium of description. Botany without designation of types is like geography without position.

In biology a species is a coherent or continuous group of organisms. In such a group the individual organisms have a common origin and may be arranged in connected series of imperceptible gradations with reference to any one character, except in cases of sexual differentiation and alternation of generations, where the coherence of specific groups is maintained by facts of life-history. A species is not constituted by any antecedent determination of the amount of difference it must present; it subsists in virtue of the fact that it has diverged and become disconnected in nature from other groups of organisms, however similar these may be.

For nomenclatorial purposes a species is a group of individuals which has been designated by a scientific (preferably a Latin adjective) name, the first individual to which the name was applied constituting the type of the species. The importance of preserving type specimens with special care is now recognized throughout the scientific world, and where specific types are lacking, naturalists are endeavoring to supply their place by specimens collected in the original localities. This may be taken as a general admission of the obvious fact that purely descriptive methods are generally insufficient for scientific accuracy and need to be supplemented by actual specimens if correct identifications are to be permanently assured.

For purposes of reference and citation specific names which appeared previous to the 'Species Plantarum' of Linnæus are not regarded in botanical nomenclature. In reality Linnæus revived rather than originated the binomial system of nomenclature, but his works embody the results of the first extensive and fairly consistent attempt at the scientific application of the nomenclatorial practice now universally followed.

The method of types applied to genera involves a similar readjustment of views. Under the analytic method of concepts a genus has been defined as a sub-division of a family, but the method of types is synthetic and places the emphasis on the connection with nature by building the genus up from below.

A genus of organisms is a species without close affinities, or a group of mutually related species. Here again the natural arrangement must have reference to the gaps in nature rather than to the logical balance of formal characters.

A generic name is established in taxonomy when it has been applied to a recognizable species. Unless the discoverer of the genus designates a type species in the same publication in which he bestows the name, the first species referred to the genus should serve as its nomenclatorial type.

The generic taxonomy of plants may be treated as beginning with Tournefort's 'Institutiones' (1700).

O. F. Cook.

Washington, D. C.

SCIENTIFIC BOOKS.

Memoirs presented to the Cambridge Philosophical Society on the occasion of the jubilee of Sir George Gabriel Stokes, Bart., Hon. LL.D., Hon. Sc.D., Lucasian Professor. Cambridge, at the University Press, 1900; New York, The Macmillan Co. 4to. Pp. xxviii + 447, with 25 plates. Price, $6.50.

The celebration of the fiftieth anniversary of the Lucasian professorship of Sir George Gabriel Stokes at the University of Cambridge, on June 1 and 2, 1899, brought together a large number of distinguished naturalists, if one may use this convenient term to include astronomers, chemists, geodesists, geologists, mathematicians, physicians, physicists and zoologists. It was one of those occasions which illustrate the essential unity of science by a spontaneous tribute of homage to an eminent specialist from workers in widely divergent fields. During the week following the celebration the Cambridge Philosophical Society held a special memorial meeting at which a number of mathematico-physical memoirs were presented. These now appear in print for the first time in the volume whose title-page is quoted above. A note on the page following the title-page states that "These Memoirs are also issued as Volume XVIII. of the *Transactions* of the Cambridge Philosophical Society." The book contains also the 'Order of Proceedings at the formal celebration by the University of Cambridge of the Jubilee of Sir George Gabriel Stokes, Bart., Lucasian Professor, 1849–1899'; and 'The Rede Lecture: *La théorie des ondes lumineuses: son influence sur la physique moderne*,' delivered by Professor Alfred Cornu on June 1, 1899. An excellent portrait of Sir George appears as a frontispiece, and the volume is supplemented by twenty-five plates illustrating the different memoirs and by an index.

The semi-popular lecture by Professor Cornu, in addition to giving an admirable summary of the century's progress in physical optics, presents the conclusions of a special study of the work of Newton in this field. To the general reader as well as to the specialist this eloquent address cannot fail to prove interesting and instructive; and the scientific world must applaud the sentiment expressed in the author's closing words:

"Que l'Université de Cambridge soit fière de sa chaire Lucasienne de Physique mathématique, car, depuis Sir Isaac Newton jusqu'à Sir George Stokes, elle contribue pour une part glorieuse aux progrès de la Philosophie naturelle."

The memoirs proper of the volume are twenty-two in number and by as many different authors. They appertain to a wide variety of subjects and are in general strictly technical in character. They are appropriately not too prolix, however; the briefest occupying only 3 and the longest only 56 pages. Pure and applied mathematics are about equally represented, though some of the papers are a little difficult to classify. The titles and authors of the memoirs are as follows:

I. 'On the analytical representation of a uniform branch of a monogenic function,' by G. Mittag-Leffler.

II. 'Application of the partition analysis to the study of the properties of any system of consecutive integers,' by Major P. A. MacMahon.

III. 'On the integrals of systems of differential equations,' by A. R. Forsyth.

IV. 'Ueber die Bedeutung der Constante *b* des van der Waals'schen Gesetzes,' von L. Boltzmann und Dr. Mache, in Wien.

V. 'On the solution of a pair of simultaneous differential equations which occur in the lunar theory,' by Ernest W. Brown.

VI. 'The periodogram of magnetic declination as obtained from the records of the Greenwich Observatory during the years 1871–1895 (Plates I. II.),' by Arthur Schuster.

VII. 'Experiments on the oscillatory discharge of an air condenser, with a determination of 'v',' by Oliver J. Lodge and R. T. Glazebrook.

VIII. 'The geometry of Kepler and Newton,' by Dr. C. Taylor.

IX. 'Sur les groupes continus,' par H. Poincaré.

X. 'Contact transformations and optics,' by E. O. Lovett.

XI. 'On a class of groups of finite order,' by W. Burnside.

XII. 'On Green's function for a circular disc, with applications to electrostatic problems,' by E. W. Hobson.

XIII. 'Demonstration of Green's formula for electric density near the vertex of a right cone,' by H. M. Macdonald.

XIV. 'On the effects of dilution, temperature and other circumstances on the absorption spectra of solution of dydimium and erbium salts' (Plates III.–XXIII.), by G. D. Liveing.

XV. 'The Echelon Spectroscope,' by A. A. Michelson.

XVI. 'On minimal surfaces,' by H. W. Richmond.

XVII. 'On quartic surfaces which admit of integrals of the first kind of total differentials,' by Arthur Berry.

XVIII. 'An electromagnetic illustration of the theory of selective absorption of light by a gas,' by Horace Lamb.

XIX. 'The propagation of waves of elastic displacement along a helical wire,' by A. E. H. Love.

XX. 'On the construction of a model showing the 27 lines on a cubic surface,' by H. M. Taylor. (Plates XXIV., XXV.)

XXI. 'On the dynamics of a system of electrons or ions: and on the influence of a magnetic field on optical phenomena,' by J. Larmor.

XXII. 'On the theory of functions of several complex variables,' by H. F. Baker.

The pure mathematician will find much of interest especially in Nos. I.–III., VIII.–XI., XVI., XVII., XX., and XXII. of these papers; while the mathematical physicist can hardly fail to discover something instructive in his lines. Together they fitly commemorate the jubilee of one who has rendered signal service in the development of both branches of mathematical science.

Scientific Papers. By PETER GUTHRIE TAIT, M.A., Sec. R. S. E., Honorary Fellow of Peterhouse, Cambridge, Professor of Natural Philosophy in the University of Edinburgh. Vol. II. Cambridge, at the University Press, 1900; New York, The Macmillan Company. 4to. Pp. 1–500. Price, $6.50.

Papers on Mechanical and Physical Subjects. By OSBORNE REYNOLDS, F.R.S., Mem. Inst. C. E., LL.D., Professor of Engineering in the Owens College and Honorary Fellow of Queens College, Cambridge. Reprinted from various transactions and journals. Vol. I., 1869–1882. Cambridge, at the University Press, 1900; New York, the Macmillan Company. Royal 8vo. Pp. xv + 416. Price, $5.00.

In these days of open and easy avenues to publication, when the papers of a fertile author are almost certain to be widely scattered in transactions and periodicals, it is a good sign to see authors and publishers alike willing to undertake the labor and expense of republication in collected form. Especially welcome—perhaps one should say essential—are such collected works to the student of the present and coming generation, for the task of finding out what has already been done in a science is generally one of the most formidable preliminaries to progress.

In the republication of the well-known scientific papers of Lord Kelvin, Sir George Gabriel Stokes and George Green, and in the more recently collected papers of Maxwell, Cayley, Adams, Lord Rayleigh and others, the University of Cambridge has set an example in the work of 'University extension' of which the academic world may well take note. Probably no more effective method of advancing knowledge could be adopted.

Volume II. of the papers of Professor Tait contains numbers LXI. to CXXXIII. They relate to a large variety of topics, ranging from the kinetic theory of gases down through addresses and reviews to notes and brief abstracts. Often, however, these notes and abstracts are full of interest and suggestion, and they serve, as Lord Rayleigh has remarked with reference to his similar republications, 'to relieve the general severity.' Nos. LIX., Report on some of the physical properties of fresh and sea water; LXVIII.–LXXXI., On the kinetic theory of gases; LXXXVIII., On impact; and CXII., On the path of a rotating spherical projectile, are the longer papers of the collection. The last cited paper will be found of special interest to the lovers of golf who may happen to possess the essential but rather rare fondness for mathematical physics. As might be expected, many of the papers refer to quaternions and their applications. Here and there also a biographical notice, like those of Listing, Kirchhoff, Sir William R. Hamilton and Rankine, gives an unexpected interest to the miscellany; and the student of the mathematico-physical sciences is delighted and instructed at every turn of a page. We may not always agree with the author, but we never find him dull.

The papers of Professor Reynolds are reprinted after the same fashion as those of Professor Tait. They are 40 in number and refer to a variety of subjects. Many of them are of great practical interest to the engineering profession; for example, those with reference to the screw propulsion and the steering of ships, the efficiency of belts, the theory of rolling friction, the action of rain and oil in calming the sea, etc. The longest paper, No. 33, is the important experimental and theoretical investigation on certain dimensional properties of matter in the gaseous state, previously published in the *Philosophical Transactions*, Part II., 1879. Unlike the volume of papers of Professor Tait, noticed above, this volume of the papers of Professor Reynolds has both a table of contents and an index.

Every one interested in the progress and in the diffusion of science will hope that the 'liberality of the Syndics of the University Press,' under whose auspices these and similar volumes have appeared, will continue to challenge admiration and commendation by the republication of additional collections.

R. S. W.

Kleiner Leitfaden der praktischen Physik. By F. Kohlrausch. Leipzig, B. G. Teubner. 1900.

Even the teachers of physics in America are so familiar with the original 'Leitfaden' that a review of this abridgment may well be essentially a comparison. The term Leitfaden (leading strings) expresses so well what is necesssary in a laboratory that it is to be regretted that we have no English equivalent. As the preface of the smaller book indicates, the larger later editions of the original have become at once a book of instructions and of reference, and has suffered as do all books which grow in that way. The new material is seldom well combined and coordinated with the old. In the new book the author has commenced all over again and distributed the matter consistently.

It is called a *smaller* guide and yet it is necessary to make a detailed comparison in order to discover that some thirty-four paragraphs have been either omitted or considerably condensed and simplified. It is, however, still a very respectable university course in physical laboratory work, and any student who thoroughly masters it will be found well equipped for advanced work. It in no sense can be called an elementary manual. It does not involve mathematics higher than algebra and simple geometry and trigonometry, logarithms and sines, cosines, etc., are assumed. More diagrams and illustrations are used than heretofore and this seems to be a real improvement. A picture book is undesirable, but well chosen diagrams and diagrammatic sketches are a great help to the beginner. This has long been recognized in light and electricity and should be judiciously extended.

Condensation is too often opposed to simplification, but in this case little or nothing of the original clearness seems to be lost in the rearrangement. Nevertheless some good hard thinking and strict attention will be required if the student is to get full benefit.

A chapter on the C. G. S. system of units is placed at the very beginning, and is necessarily very brief, and, although very important, may well be used as matter for reference from time to time as the units arise rather than to be learned at the outset.

Considered from the point of view of the teacher in the general physical laboratory, this book may well supplant the earlier treatise and relegate it to the shelf with other books of reference, and to the advanced special laboratories. It is perhaps well to warn those less familiar with the subject and with German idiom that many words which are identical with the English are used in a different sense; *e. g.*, hydrometer, in English is equivalent of araeometer, but Kohlrausch applies it to the communicating tubes used for densities of liquids. In fact in the chapter on the absolute units it would be essential that a student have the technical English equivalents, and even then some of the German units seem to be superfluous repetitions, and it should be always left clearly impressed upon the mind that 'work,' for example, is always work and always measured in the same unit no matter how the work may be accomplished; and similarly with other units.

The sections on light and especially on electricity and magnetism are very good and complete. The diagrams in the electrical measurements leave nothing to be desired and make one regret that the author did not see fit to illustrate the other subjects with the same liberality and good judgment.

A few useful tables and a good alphabetical index contribute largely to the usefulness of the book, which will be welcomed by every laboratory instructor in physics in college or university.

W. Hallock.

Education in the United States A Series of Monographs prepared for the United States exhibit at the Paris Exposition, 1900. Edited by NICHOLAS MURRAY BUTLER, Professor of Philosophy and Education in Columbia University. Two volumes. Albany, N. Y., J. B. Lyon Co. 1900.

This publication was contributed to the educational exhibit of the United States at the Paris Exposition by the State of New York. Besides a characteristically vigorous, although rather brief 'Introduction' by the editor, the work consists of nineteen monographs as follows: Volume I.: 'Educational Organization and Administration, by President Draper of the University of Illinois; 'Kindergarten Education,' by Miss Susan E. Blow of Cazenovia, New York; 'Elementary Education,' by Hon. Wm. T. Harris, United States Commissioner of Education; 'Secondary Education,' by Professor E. E. Brown of the University of California; 'The American College,' by Professor A. F. West of Princeton University; 'The American University,' by Professor E. D. Perry of Columbia University; 'Education of Women,' by President Thomas of Bryn Mawr College; 'Training of Teachers', by Professor B. A. Hinsdale of the University of Michigan; 'School Architecture and Hygiene,' by Principal Gilbert B. Morrison of Kansas City, Mo.; Volume II.: 'Professional Education,' by James Russell Parsons of the University of the State of New York, Albany, N. Y.; 'Scientific Technical, and Engineering Education,' by President Mendenhall of the Technological Institute, Worcester, Mass.; 'Agricultural Education,' by President Dabney of the University of Tennessee; 'Commercial Education,' by Professor E. J. James of the University of Chicago; 'Art and Industrial Education,' by Mr. I. E. Clarke of the United States Bureau of Education; 'Education of Defectives,' by Principal E. E. Allen of Overbrook, Pa.; 'Summer Schools and University Extension,' by Professor H. B. Adams of Johns Hopkins University; 'Scientific Societies and Associations,' by Professor J. McK. Cattell of Columbia University; 'Education of the Negro,' by Principal Booker T. Washington of Tuskegee, Ala.; 'Education of the Indian,' by Superintendent W. N. Hailman of Dayton, Ohio. There is no summary of the contents or chief propositions of each monograph, as there might well be; but there is a good general index in each of the two volumes. Paper and type are excellent.

Any detailed discussion of such a comprehensive treatise is, of course, out of the question in a brief review like this. One can only touch on some of its most important features, and, incidentally, give a general estimate of the work as a whole.

This collection of monographs is a timely contribution to our educational literature of uncommon interest and value. Our contemporary educational resources and problems have never before been dealt with, in a single treatise, so comprehensively, clearly and tersely. The two volumes, together, comprise less than 1000 pages (973), and yet nearly every phase of our varied provision for education receives attention.

Professor Butler's excellent judgment as an editor is shown both in the general plan of the work and in the selection of the writers of the several monographs. He naturally intended that the work should be a worthy exposition of our whole educational endeavor by persons whose statements of fact could be trusted, and whose conceptions of our educational needs would command respect. In the introduction he tells us "that the present work * * * describes the organization and influence of each type of formal school; it takes note of the more informal and popular organizations for popular education and instruction; it discusses the educational problems raised by the existence of special classes and of special needs, and sets forth how the United States has set about solving these problems. It may truly be said to be a cross-section view of education in the United States in the year 1900."

This description of the scope and purpose of the completed work is, on the whole, just. Such divergences from this description as the work actually presents may be appropriately described, for the most part, as sins of omission. Some important details of the topics considered have received rather scant treatment, and some decidedly important phases of our educational resources and the corresponding problems have not been treated at all.

The best and most interesting portions of the treatise are the monographs of Volume I., and the four monographs of Volume II., on 'Professional Education,' 'Scientific, Technical and Engineering Education,' 'The Education of Defectives,' and 'Scientific Societies and Associations.' The last-named paper is the first appropriate recognition, in print, of extremely important and far-reaching organized influences on our educational activity.

The sins of omission, referred to above are perhaps due to haste in preparation, and to an exaggerated fear of producing too large a treatise. The time for preparation was, doubtless, short, and limitations of size are, of course, necessarily imposed on public documents. Nevertheless, the absence of a monograph on physical training and athletics, or, at least, of a discussion of this topic in connection with school hygiene; the omission of all mention, save incidentally, of evening schools, of which the number and variety are large; the omission of a monograph on the different kinds of our private and endowed schools, some of which, both old and new, are among our most cherished educational resources, and extremely useful in meeting some educational needs not yet adequately met by public schools; the omission of all mention of vacation schools, even if these schools are not yet sufficiently developed to be entitled to a separate monograph;—these omissions from a work exhibiting the educational resources and problems of the United States are to be regretted. So too, it is difficult to see why manual training should not be entitled to a separate monograph as well as commercial education. The writer of the monograph on 'Art and Industrial Education,' necessarily confined himself largely—and, apparently, with no space to spare—to drawing and art; the result is that manual training is nowhere adequately discussed in the entire treatise. No one can doubt that it should be.

Similarly some of the monographs suffer unnecessarily by condensation. In Mr. Draper's paper on 'Organization and Administration' the historical introduction is too brief and fragmentary to possess much value; and there is not, in the paper, even a single illustration of the actual organization and important details of the administration of the school system of an American city. Moreover the whole paper is, with one exception, the shortest in the entire series; and yet the topic with which it deals is second to none in importance. So too, the paper on 'Secondary Education,' which is one of the most valuable and interesting of them all, lacks a very important detail. Mr. Brown justly gives adequate attention to the importance assumed by *electives* in our secondary education; and while he very properly points out that, in some form, electives have long been recognized in our secondary school programs, his monograph does not clearly convey the impression—as it should—that there are many schools throughout the country to-day in which the elective system is dominant. This could have been done easily by inserting two or three typical programs of such schools.

The elective system naturally receives attention again in Mr. West's monograph on 'The American College.' From the general tone of Mr. West's presentation it is not difficult to conclude that he does not favor an elective college course for the B. A. degree. After citing several examples of the different ways in which elective courses for the B. A. degree are administered, Mr. West remarks, "These examples are sufficient to indicate the variety of meaning found in colleges which have changed the historical significance of the Bachelor of Arts degree." No doubt they are. But they convey no impression of the richer and deeper culture for each individual which the B. A. degree represents under an elective system as compared with a prescribed system, in our better colleges, and they do convey the idea that, on the whole, the 'changed historical significance' of the B. A. degree as conferred by these institutions is neither widely accepted nor generally approved; and this, to say the least, is an extremely doubtful assumption.

But it is unnecessary to extend examination to other details of this important series of monographs. In spite of some important omissions and occasional minor defects in detail, the work is, as stated in the beginning of this review, a timely and valuable addition to our educational literature. It will serve to give a generally sound view of our provision for education to interested foreigners; and to our own students of education in this country, whether superintendents, principals, teachers or university students, it is a store-house of information; at the same time it suggests our many and complex educational problems vividly, and it shows their intimate relation to the other problems of our national life. Its great value to all students of our social and educational problems is indisputable, both as a book of reference and as a foundation for further study.

PAUL H. HANUS.

HARVARD UNIVERSITY.

Catalogue of the Lepidoptera Phalænæ in the British Museum. Vol. II., Arctiidæ (part). By SIR GEORGE F. HAMPSON, Bart.

This volume is similar to Volume I., issued in 1898, and which treated of the family Syntomidæ. It contains the same advantages of practicable keys to genera and species, being simply invaluable to the working entomologist.

The title is misleading, as the work is really a monograph of the groups treated, embracing the known fauna of the entire world, not simply a catalogue of the species represented in the collection of the British Museum, though it may be noted that this collection possesses examples of 77 per cent. of the species described. Each genus and species is described briefly, but characteristically.

The volume contains the subfamilies Nolinæ and Lithosiinæ of the Arctiidæ, as classified by the author. These groups would seem to be more properly of family rank, especially the Nolinæ, which, on larval and pupal characters, show a separate origin from a low Tineid type to that of the Lithosiinæ, which are themselves a true derivative of the Arctiinæ and properly classified here. The larval characters of these groups are, in fact, well marked, though not clearly brought out in the volume before us.

On page 256 we note a curious error, where *Seirarctia bolteri* Edw. is given as a synonym of *Protosia terminalis* Walk., whereas it is really the same as *Halisidota ambigua* Streck., belonging in the Arctiinæ.

There are a number of curious modifications of structure clearly brought out, such as the antennæ of Chamaita, the hind wings of Boenasa and the larva of *Nola argentalis;* but for the details of these we must refer to the book itself.

HARRISON G. DYAR.

DISCUSSION AND CORRESPONDENCE.

THE PSYCHOLOGY OF PITY.

TO THE EDITOR OF SCIENCE: The interesting study of Pity in the July *American Journal of Psychology* suggests some further considerations. In the first place pity as grief *for* another's pain is not sufficiently set off from mere sympathy, *Mitleid*, in the literal sense as partaking of another's pain by direct contagion. All kinds of emotions are contagious, and in the case of fear we denote it by a special name, panic. But it is plain that panic is not pity for fear, but really hinders it; and in general the mere partaking an emotion or feeling interferes so far with emotion for emotion, such as pity. Emotion by contagion adds no new psychic quality, as panic fear is simple fear; but pity is a new specific reaction, and not a mere communication. In contagious painful feeling we seek to suppress the cause; but pity moves us to seek the sufferer, to relieve him not for our own sake, but for his sake. Pity as altruistic grief has thus a quality of its own, as has altruistic joy as distinguished from contagious joy.

Again, this study scarcely notes whether animals pity, and how far pity plays a part in the general struggle of existence as between competitors and as between the hunters and hunted. We judge it likely that the biological origin of pity in its general form is the perversion of parental sympathy in the predaceous animals by the prey as a last resort, the prey thus by cunning circumventing the stronger. The occasional adoption by lions and other ferocious animals in menageries of small beasts offered them as food suggests this, and a closer study of beasts in their natural habitat may show some indications of pity-inspiring as a sub-human method in life and death issues. Certain it is that animals sometimes consciously or unconsciously take advantage of the human hunter's pity. Thus Carstensen in his 'Two Summers in Greenland' gives an instance of an Eskimo hunter who was so affected by the sad appealing eyes of the seals as he was about to despatch them that he was unable to shoot, and was obliged to give up hunting to the detriment of his own family. Monkeys and giraffes often escape human hunters through the pity their actions inspire when driven to extremity, as all readers of sporting books will recall. Hough reports that even the bear when cornered and completely at the mercy of the hunter sometimes exhibits a pitiful submission and despair.

A third point which deserves more consideration is whether, as the authors represent, the literature of pathos is preferred by mankind in general to that of joy (p. 581). Certainly humorous and comic papers abound, and most news sheets and general periodicals have a section devoted to wit and humor, whereas there are no journals or portions thereof devoted to pathos. Most novel readers prefer, I think, the tale where everything turns out right in the end. The vast vogue of farce and burlesque on the stage is another evidence of popular taste. With the modern development of humor especially with the Anglo-Saxon races, much annoyance and suffering that would once have been pitiable in ourselves and others, is merely laughable. On the whole the present tendency seems to be to restrict the field of pity and to intensify and rationalize it in that field.

The pleasure of pity is little referred to, but the survival theory is mentioned: "It seems as though our race had developed modern civilization in which the leisure field is so vastly widened and the pain field so greatly reduced, too suddenly, and that our nervous system is not yet wonted to so much ease and luxury and had therefore to hark back to play over the old litany of sorrow and pain in the falsetto way of the stage novel and poem." But certainly the primary and main pleasure in pity is that it emphasizes power of protector over protégé, and the secondary source is in seeing the desired relief effected. Pity which is in no wise objective and effective, but solely subjective indulgence—*e. g.*, pleasure in the tragic poem—is like other emotion for its own sake, an art sphere, a late severance of emotion and action, and so while resting upon the past is not to be described as survival, but as the progressive development of experience for its own sake. Thus literature and music idealize pity into pure and subtle forms, and the soul, dissolved in infinite, delicious sadness, experiences the most evanescent and distant development of maternity-paternity.

HIRAM M. STANLEY.

LAKE FOREST, ILL., Sept. 10, 1900.

THE KIEFFER PEAR AND THE SAN JOSÉ SCALE.

IN his New Jersey Report for 1897 (p. 484), Dr. J. B. Smith writes: "A curious fact was emphasized this year; in an orchard of Kieffer trees, when once it becomes infested [with San José scale], the scales flourish as well as anywhere, and the trees become as completely incrusted as any other variety. But where Kieffer is mixed with other varieties it remains almost exempt, even where neighboring trees are badly infested. This was noticed several times, and Le Conte seems almost less troubled than Kieffer."

In the Yearbook of the Department of Agriculture for 1897 (p. 415), Messrs. Swingle and Webber write: "The Kieffer and Le Conte pears * * * are almost certainly hybrids between the Chinese sand pear (*Pyrus sinensis*) and the common European pear (*P. communis*), since both were grown from seeds of the sand pear obtained from trees which were surrounded by various European pears." On the same page they write of "the problem which the French hybridizers have successfully solved in obtaining hybrid grapes combining the resistance to Phylloxera of the American grape and the quality and size of the fruit of the European grape."

I have elsewhere set forth my reasons for believing that the San José scale is a native of eastern Asia, and, if this is the case, does it not appear that our hybridizers have unwittingly obtained a pear combining resistance to the San José scale with the good qualities of the European pears, the fruit of the Chinese sand pear being very poor? The facts, at all events, are strongly suggestive of such a thing, and point, perhaps, to the original food-plant of the San José scale.

T. D. A. COCKERELL.

NOTES ON PHYSICS.

ARCHITECTURAL ACOUSTICS.

ABOUT five years ago Professor W. C. Sabine was directed by the Corporation of Harvard University to propose means for remedying the acoustical defects of the lecture room of the Fogg Art Museum at Cambridge. About two years were spent in experimenting on this room and permanent changes were then made.

The experimental work done in connection with this lecture room has led Professor Sabine to take up seriously the general question of architectural acoustics and we are promised a series of papers on this subject the first of which, on reverberation, is published in a recent number of the *American Architect.*

In an introductory chapter Professor Sabine gives a clear and comprehensive statement as to the different ways in which sound is affected by being confined in an audience room, substantially as follows:

The *loudness* of the sound is as a rule greater at a given distance from the speaker than it is in the open air.

The *character* or *timbre* of a complex sound is more or less altered by re-enforcement of certain of its elementary tones by resonance, or by the re-enforcement or weakening of some of its elementary tones at certain parts of the room by interference. This alteration of the character or timbre of a complex sound Professor Sabine calls *ditortiosn.*

Thė sound *persists* in a room for a considerable time after the sounding body ceases to vibrate. This is due to the more or less complete reflection and re-reflection of the sound from the walls, floor and ceiling. This persistence of sound in a room Professor Sabine calls *reverberation.* It causes the successive sounds in articulate speech to overlap and become confused. Especially the sonorous vowel sounds persist, and obscure the delicate and fleeting variety of the consonant sounds.

The question of loudness becomes a serious matter only in very large audience rooms.

Sound distortion and reverberation depend very largely upon the same conditions. Thus the extent to which an air column will enforce the tone of a tuning fork depends largely upon the length of time the air column will continue to vibrate when left to itself after having been set vibrating. Sound distortion is not so serious a matter as reverberation and, since the two depend largely upon the same conditions, it seems that reverberation only need be considered in any practical case.

The reverberation of a room, measured by the duration of a sound after the sounding body ceases to vibrate, depends upon the absorbing power of the walls and of other reflecting surfaces and upon the size of the room. Thus heavily draped walls or walls lined with thick felt absorb much and reflect little of the sound which strikes them, and a sound persists but a short time in a room of which a considerable portion of walls are padded or draped. An audience also absorbs a large portion of a sound in a room and greatly reduces reverberation. A larger room has greater reverberation than a small room, walls being of similar material, because the sound has farther to travel between succeeding reflections, and a greater time is therefore required for the absorption of a given portion of the sound.

Professor Sabine found that the note of a particular organ pipe remained distinctly audible in the lecture-room of the Fogg Art Museum for 5.6 seconds after the blowing of the pipe ceased. The method proposed and carried out for the reduction of reverberation was to line a considerable portion of the walls of the room with a thick hair felt.

Professor Sabine has determined, by a very ingenious method, the absorbing power of a variety of wall surfaces, such as brick, plaster on brick, plaster on lath, glass and boards, and he has shown that the reverberation of a room can be pre-determined by calculation in terms of the size of the room and the character of its walls.

W. S. F.

NOTES ON INORGANIC CHEMISTRY.

A VERY considerable amount of work is being done at the present time in filling up the many gaps that exist in descriptive inorganic chemistry, especially in connection with the rarer elements. The ultimate aim of this work is to determine more accurately the relation of the elements to each other, and incidentally it is doing much to clear up the Periodic Law. Considering the gaps and discrepancies in the work that has been done upon the element *thallium* since its discovery by Crookes in 1861, it is hardly strange that two workers should have selected this for investigation. In the last *American Chemical Journal* a paper by Professor Cushman, of Bryn Mawr, takes up the first chapters of a study of the halogen compounds of thallium; while the last number of the *Zeitschrift für anorganische Chemie* contains a long article by Professor Richard Jos. Meyer, of Berlin, on trivalent thallium, with especial reference to the halogen compounds and the nitrates. There are some very considerable discrepancies between the observations of these two chemists, which will doubtless be cleared up by further study and by comparison. The most important result of Cushman's is the preparation of two isomeric compounds of the formula $Tl_4Cl_3Br_3$, or as they may be written, $TlCl_33TlBr$ and $TlBr_33TlCl$. Isomerism of this character, while common in organic chemistry, is very rare in inorganic chemistry, and many have asserted that it does not exist. Meyer has added to our knowledge a large series of new thallium salts, and brings out very beautifully the analogies which exist between thallium and gold. As both these authors are continuing their researches, there may be expected decidedly interesting and valuable contributions to our knowledge of thallium in the near future, as each profits by the work of the other.

A NEW and important addition to our knowledge of the chemistry of radium appears in the *Comptes Rendus*, from the pen of Madame Curie. By carefully fractioning many samples of radiferous barium, she has gradually accumulated small quantities of nearly pure radium; indeed, one specimen of a few centigrams was pronounced practically pure and was used for spectroscopic observations. With a specimen of 0.4 gramme concentrated radium, which, however, contained more or less barium, an atomic weight determination was made. This gave an atomic weight of about 174, while the atomic weight of barium is 137.5. This figure of 174 is a minimum, and M. Demarçay considers from spectroscopic observation of the specimen that there was rather more radium in it than barium. In any case it would follow that the atomic weight of radium must be decidedly higher than 174. This would seem to be very strong evidence that radium is an individual element and not a peculiar form of barium.

J. L. H.

ACADEMEI DEI LINCEI OF ROME.

AT the anniversary meeting of the Academei dei Lincei of Rome, Professor Cremona read a biographical notice of Professor Beltrami, who was president of the Academy at the time of his death. The prizes of the Academy announced in the *Atti* are summarized in *Nature* as follows: For the Royal prize of 1000 francs for normal and pathological physiology six candidates entered, and a large number of essays of considerable merit were submitted by them. The prize has been adjudged to Professor Giulio Fano, of Florence, for sixteen papers, dealing, amongst other subjects, with the physiology of the embryonic heart, the doctrine of experimental psychology, the organ of hearing, the graphic registration of respiratory chimism and reflex movements, the latter being a continuation of previous researches on the organs of *Emys Europea.* Of the six candidates for the Royal prize for geology and mineralogy, two were considered worthy of the award, which was therefore divided equally between them. One of the successful candidates, Professor De Lorenzo, chose geological subjects, and sent in about twenty essays, the most important of which dealt with the Trias of the environs of Lagonegro, the Mesozoic mountains of Lagonegro, geological observations on the Apennines of the southern Basilicate and geological studies of the southern Apennines. Professor Giorgio Spezia's work, on the other hand, was entirely mineralogical, dealing with the influences of temperature and pressure, respectively, on the chemical metamorphism of rocks and minerals. From a long and laborious series of experiments, many of them occupying five or six months, the author concluded that pressure has little or no effect, while the influence of temperature is considerable. The results have a special bearing on the theory of quartz formation. The Royal prize for advances in archeological science was adjudged to Dr. Paolo Orsi, of Roveredo, for his investigations of the antiquities of Eastern Sicily. Dr. Orsi has thrown quite a new light on the prehistoric development of the people known as the Siculi, from the neolithic epoch down to the period of expansion of the Greek colonies. A special prize for philosophy and moral science had been offered for an essay dealing with either the theory of consciousness or the foundations of practical philosophy. This prize has been divided equally between Professor Bernardino Varisco and Professor Francesco de Sarlo. The Minister of Public Instruction offered a sum of 3400 lire for two prizes in the physical and chemical sciences, and a like sum for two prizes in the philological sciences, the prizes being confined to teachers in secondary schools. The committee for the prizes in the physical and chemical sciences have awarded two equal prizes—one to Professor O. Marco Corbino, more especially for his work on light traversing metallic vapors in a magnetic field, and the other to be divided between Professors Carlo Bonacini and Ricardo Malagoli, more especially for their joint papers on Röntgen rays. In philology, the prizes have been divided up into a number of minor awards, distributed between Signori Giuseppe Vandelli (whose work stood first), Antonio Belloni, Astorre Pellegrini, Giuseppe Rua, Giuseppe Lisio, Augusto Balsano, Giovanni Negri and Guglielmo Volpi.

THE IMPORTATION OF LIVING ANIMALS.

THE Hon. James Wilson, Secretary of Agriculture, has given notice that under the authority vested in the Secretary of Agriculture by Section 2 of the Act of Congress approved May 25, 1900, entitled 'An Act to enlarge the powers of the Department of Agriculture, prohibit the transportation by interstate commerce of game killed in violation of local laws, and for other purposes,' the list of species of live animals and birds which may be imported into the United States without permits is extended as hereinafter indicated. On and after October 1, 1900, and until further notice, permits will not be required for the following mammals, birds and reptiles, commonly imported for purposes of exhibition: *Mammals*—Anteaters, armadillos, bears, chimpanzees, elephants, hippopotamuses, hyenas, jaguars, kangaroos, leopards, lions, lynxes, manatees, monkeys, ocelots, orang-outangs, panthers, raccoons, rhinoceroses, sea-lions, seals, sloths, tapirs, tigers or wildcats. *Birds*—Swans, wild doves, or wild pigeons of any kind. *Reptiles*—Alligators, lizards, snakes, tortoises or other reptiles. Under the provisions of Section 2 of said Act (as stated in Circular No. 29 of the Biological Survey, issued July 13, 1900), canaries, parrots, and domesticated birds such as chickens, ducks, geese, guinea fowl, peafowl and pigeons are subject to entry without permits. But with the exception of these species and those mentioned above, special permits from the Department of Agriculture will be required for all live animals and birds imported from abroad, and such permits must be presented to the collector of customs at the port of entry prior to delivery of the property.

STREET CARS IN GLASGOW.

THE street car system of Glasgow is owned and operated by the city under the direct supervision of a committee of the town council. The report for the year ended May 31, 1900, as abstracted by our consul, shows that the total length of double track operated by the city is 41 miles. The gross capital expenditures for the system since 1894 (independent of operating expenses) have been $5,164,975, and the present indebtedness is $4,061,806. The capital invested is $4,559,502. Of the 41 miles of double track, five miles have electric traction, the rest being operated by horses. The total receipts of the system during the year were $2,286,850. The working expenses were $1,676,412, leaving a balance of $610,438, of which there was expended some $84,000 for interest on capital, $57,501 for sinking fund, $156,096 for depreciation written off capital, etc. One item of $60,000 consists of payments made to the general revenue fund of the city, which is in lieu of the amount which the city would receive in taxes, it is presumed, were the system operated by a private company. The balance goes into the reserve fund. There are 3400 persons employed, including 100 clerks. The general manager receives $6800; the chief engineer, $2400; the electrical engineer, $2000; and the mechanical engineer, who has charge of the powerstation, $1216. Point boys receive 28 cents per day; trace boys, from 40 to 52 cents per day; car cleaners, from 88 cents to $1 per day; drivers, conductors, and motormen, from $1 to $1.12 per day. These rates apply to Sundays and week days alike. The rolling stock consists of 384 horse cars, 132 electric cars (47 only of which are now running), 17 omnibuses, 39 lorries, and numerous carts, wagons, and vans. There are 4411 horses. Work is now progressing, with the object of changing the entire system to electric traction, which it is hoped to have completed within the next eighteen months. No underground conduits will be used, according to the present plans. Fares range from 1 cent for first half mile to 2 cents for a mile; the longest ride is 6 miles, costing 6 cents. No transfers are issued and tickets are not used. The committee of the town council having supervision of the tramways receives no compensation. For that matter, however, no member of the city government of Glasgow, inincluding lord provost, town councilors, and bailies (police judges), receives compensation. The city of Glasgow has a population of about 850,000, and spreads over an area of nearly 12,000 acres. There are no electric or other tramways extending out of Glasgow to other towns or cities. Within the city is an underground cable road which makes a circuit of about five miles, and is owned and operated by a private company. The rate of fares on this road is about the same as that prevailing on the surface roads.

SCIENTIFIC NOTES AND NEWS.

Dr. N. L. Britton, director-in-chief of the New York Botanical Garden, has been given leave of absence and is in attendance at the International Congress of Botany in Paris, in which assembly he represents the Garden, and is also an official delegate of the United States. He will visit many of the museums of France and England before he returns. The Board of Managers have designated Dr. D. T. MacDougal as acting director-in-chief of the New York Botanical Garden in Dr. Britton's absence.

Dr. B. T. Galloway, chief of the Division of Vegetable Pathology and Plant Physiology, has been placed in charge of the grounds of the U. S. Department of Agriculture.

Dr. Timbrell Bulstrode, one of the members of the Food Preservatives Committee, and Mr. Charles J. Huddart, the secretary, have, during the past month, visited Amsterdam, Hamburg and various places in Denmark for the purposes of studying the dairying industry and the methods of transport of dairy produce, with special reference to the milk and butter supplies in Holland, Germany and Denmark, and the butter export trade, in relation to the use or non-use of chemical preservatives.

The Duke of Abruzzi has been entertained by the Geographical Society of Christiania, the address of welcome being made by Professor Reusch. He has proceeded to Italy.

The Danish scientific expedition for the exploration of East Greenland, under Lieutenant Amdrup, has reached the shore. The Swedish Kolthoff expedition near Sabine Island found a mast with a Danish flag and a communication from Lieutenant Amdrup to Captain Sverdrup.

Thomas Davidson, well known as an author of philosophical and educational works and as a lecturer, died at Montreal on September 14th, aged sixty years. Mr. Davidson was born in Scotland, but has been living in the United States for the past twenty-five years.

Dr. Lewis Albert Sayre, one of the most eminent surgeons of New York City, died on September 21st in his 81st year. He was one of the founders of Bellevue Medical College and was professor there until the college was united with the New York University two years ago.

There will be a civil service examination on October 23rd and 24th for the position of assistant in the Nautical Almanac office, with a salary of $1000 a year. The examination will be on the mathematical topics required for the computations. On October 23rd there will be an examination for the position of assistant physical geologist in the U. S. Geological Survey at a salary of $600 a year. The examination is chiefly on physics, but French and German are also included. On November 14th, there will be examinations for preparator in vertebrate paleontology and skilled laborer in the U. S. National Museum, with salaries of $900 and $720 respectively. The examinations will be on experience and practical questions regarding the mounting and care of vertebrate fossils. On October 23rd, 24th, and 25th, there will be held the examination we have already noted for the position of chemical geologist in the U. S. Geological Survey with a salary of $1400.

THE Grand Prize of the Paris Exposition has been awarded to the Division of Pomology of the Department of Agriculture, and four gold medals have been awarded to the United States in the horticultural group.

THE Rothamsted Experimental Station established by Sir John Bennet Lawes was some time before his death made over to trustees who hold it for the British nation. In addition to the land and laboratory it has been provided with an endowment of £100,000.

AN elaborate exhibition has recently been held in the Botanical Museum and Conservatories of the Botanical Gardens at Berlin of the plants obtained in South and Central America by Dr. P. Preuss.

AS has already been stated the Nobel prizes will be awarded on the anniversary of the death of the founder, and it is expected that the first award will be made on December 10, 1901.

MAJOR A. ST. HILL GIBBONS has returned from Africa after an absence of two years and three months. We learn from the London *Times* that the expedition covered over 13,000 miles, in addition to travel by railway or steamship routes. The main object of Major Gibbons's journey was to complete the survey of the Barotse country and to determine the tribal distribution there. In this he was successful, and the whole country from the Kafukwe River on the east to the Kwito River on the west and the Zambesi-Congo watershed to 18° south latitude, or a total area of over 200,000 square miles, has beeu hydrographically and ethnographically surveyed. An interesting feature of Major Gibbons's work in this region was the discovery of the source of the Zambesi at a point nearly 100 miles distant from its supposed position. On the completion of his work in Barotseland Major Gibbons, in order to extend the scope of the expedition, separated from his companions and adopted the northern route, traveling by way of the chain of lakes to the Upper Nile. According to his charts considerable amendments to existing maps will be necessary, both with reference to the relative position, shape and extent of most of the Great Lakes, especially in the case of Lakes Kivu and Albert Edward, the latter of which is now found to be absolutely different in shape and size from the description given in existing maps. By the completion of this journey Major Gibbons has personally travelled a greater distance than any other explorer in Africa, probably not excluding Livingstone. He has never had occasion to use his rifle in anger, and he is proud of the fact that he has never killed a native nor lost one of his boys from death, either by disease or misadventure. He has brought home a large amount of valuable data on the general and political situation of the countries through which he has traveled and over 300 photographs, and his sporting collection includes a white rhinoceros from the Upper Nile.

THE report of the expeditions organized by the British Astronomical Association to observe the total Solar Eclipse of May 28, 1900, will be contained in a volume shortly to be issued from the office of *Knowledge*. The work will be edited by Mr. E. Walter Maunder, F.R.A.S., and will contain many fine photographs of the various stages of the Eclipse.

THE New York *Medical Record* states that a firm of manufacturing chemists in England having applied for a license to perform experiments upon living animals for the purpose of standardiziug antitoxins, the Royal College of Physicians was requested to give an opinion as to the advisability of granting the license. The reply of the College was that, while these experiments were absolutely necessary to the advance of pharmacology, the granting of such licenses to commercial firms was very undesirable. The standardization of antitoxins should be done in a government laboratory into which the question of money-making did not enter.

The results of measurements of various rivers and the observations of height have been published by the U. S. Geological Survey in a series of Water-Supply Papers, Nos. 35 to 39, inclusive, arbitrary division into five parts being necessary by the requirements of law limiting these papers to 100 pages each. They are as follows:

No. 35 (Part I.) rivers flowing into the Atlantic Ocean from Maine to Virginia.

No. 36 (Part II.) rivers flowing into the Atlantic south of Virginia.

No. 37 (Part III.) rivers flowing from the eastern Rocky Mountain area.

No. 38 (Part IV.) rivers tributary to the Colorado, the interior basin, and Columbia River.

No. 39 (Part V.) California streams, and rating tables.

Application for these papers should be made to Members of Congress, by whom 4000 copies of the 5000 printed are distributed, or to the Director of the U. S. Geological Survey, Washington, D. C.

In an article in *Nature* on latitude-variation, earth-magnetism and solar activity Dr. J. Halm summarizes his conclusions as follows: (1) The changes in the motion of the pole of rotation round the pole of figure are in an intimate connection with the variations of the earth-magnetic forces. (2) Inasmuch as the latter phenomena are in a close relation with the state of solar activity, the motion of the pole is also indirectly dependent on the dynamical changes taking place at the sun's surface. (3) The distance between the instantaneous and mean poles decreases with increasing intensity of earth-magnetic disturbance. (4) The length of the period of latitude-variation increases with increasing intensity of earth-magnetic disturbance. (5) In strict analogy with the phenomena of auroræ and of magnetic disturbance, the influence of the eleven-years' period of sun-spots, as well as of the 'great' period, is clearly exhibited in the phenomenon of latitude-variation; and the same deviations from the solar curve as are manifested by the auroræ are also evident in the motion of the pole. (6) The half yearly period of the earth-magnetic phenomena influences the motion of the pole of rotation in such a way that its path, instead of being circular, assumes the form of an ellipse, having the mean pole at its center. (7) The half-yearly period also explains the conspicuous fact of a rotation of the axes of the ellipse in a direction opposite to that of the motion of the pole.

Judge Townsend in the U. S. Circuit Court for the District of Connecticut has handed down a decision sustaining Mr. Tesla's patents for the rotating magnetic field, but the case will doubtless be appealed to the Supreme Court. The learned judge described the progress of electrical knowledge as follows: "The search lights shed by defendant's exhibits upon the history of this art only serve to illumine the inventive conception of Tesla. The Arago rotation taught the schoolboy fifty years ago to make a plaything which embodied the principle that a 'rotating field could be used to rotate an armature.' Baily dreamed of the application of the Arago theory by means of a confessedly impossible construction. Deprez worked out a problem which involved the development of the general theory in providing an indicator for a ship's compass. Siemens failed to disclose the 'suitable modification' whereby his electric light machine might be transferred into a motor, and Bradley is almost equally vague. Eminent electricians united in the view that by reason of reversals of direction and rapidity of alternations an alternating current motor was impracticable, and the future belonged to the commutated continuous current. It remained to the genius of Tesla to capture the unruly, unrestrained and hitherto opposing elements in the field of nature and art and to harness them to draw the machines of man. It was he who first showed how to transform the toy of Arago into an engine of power; the 'laboratory experiment' of Baily into a practically successful motor; the indicator into a driver; he first conceived the idea that the very impediments of reversal in direction, the contradictions of alternations might be transformed into power producing rotations, a whirling field of force. What others looked upon as only invincible barriers, impassable currents and contradictory forces, he seized, and by harmonizing their directions utilized in practical motors in distant cities the power of Niagara."

PROFESSOR E. RAY LANKESTER communicates to *Nature* a letter from Captain Hind remarking that "It is a curious fact that a bird which is so valuable as Buphaga in clearing parasitic insects from cattle that we lately agreed to give it special protection at the International Conference on the Preservation of African Wild Animals, should now, by a sudden change of conditions induced by man, become a dangerous and noxious creature. This fact shows how difficult is the problem presented by the relations of civilized man to a fauna and flora new to his influence." The letter is as follows: "The common rhinoceros-bird (*Buphaga erythroepyncha*) here formerly fed on ticks and other parasites which infest game and domestic animals; occasionally, if an animal had a sore, the birds would probe the sore to such an extent that it sometimes killed the animal. Since the cattle plague destroyed the immense herds in Ukambani, and nearly all the sheep and goats were eaten during the late famine, the birds, deprived of their food, have become carnivorous and now any domestic animal not constantly watched is killed by them. Perfectly healthy animals have their ears eaten down to the bone, holes torn in their backs and in the femoral regions. Native boys amuse themselves sometimes by shooting the birds on the cattle with arrows, the points of which are passed through a piece of wood or ivory for about half an inch, so if the animal is struck instead of the bird no harm is done. The few thus killed do not seem in any way to affect the numbers of these pests. On my own animals, when a hole has been dug, I put in iodoform powder, and that particular wound is generally avoided by the birds afterwards; but if the birds attack it again, they become almost immediately comatose and can be destroyed. This remedy is expensive and not very effective. Is there any other drug you could suggest that would be less likely to be detected? Perhaps you know that I reported three years ago that these birds rendered isolation under the cattle plague regulations useless in some districts, as I proved beyond doubt they were the only means of communication between clean and infected herds under supervision, a mile or two apart. These birds I have never seen on the great herds of game on the open plains, but I have seen them on antelope and rhinoceros in the immediate neighborhood of Masai villages and herds of cattle; on the other hand, I have never seen the small egret on cattle, though often on rhinoceros and gnū."

THE work done at the Pasteur Institute in Paris, so far as regards the treatment of rabies, is set forth in the last issue of the *Annales de l'Institut*, which is abstracted in the London *Times*. It appears that 1614 persons were inoculated, of whom 1506 were French, 74 English and Indian, 15 Belgian, seven Swiss, four Greeks, three Spanish, two each Dutch and Turks, and one from Morocco. Of the 1614 under treatment, 188 were bitten on the head or face, 965 on the hands and 464 on other parts of the body; while the number of deaths, excluding six which occurred before the treatment was completed, did not exceed four. The full return of the treatment since Pasteur commenced it is as under:

Year.	No. of persons treated.	No. of deaths.	Rate of mortality. per cent.
1886	2671	25	.94
1887	1770	14	.79
1888	1622	9	.55
1889	1830	7	.38
1890	1540	5	.32
1891	1559	4	.25
1892	1790	4	.22
1893	1648	6	.36
1894	1387	7	.50
1895	1520	5	.33
1896	1308	4	.30
1897	1521	6	.39
1898	1465	3	.20
1899	1614	4	.25

It must be pointed out that since the Pasteur Institute was started in Paris several others have been opened in different European countries, so that it is not surprising to find that the number of persons under treatment has never been so large as it was in the first year.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. A. C. BARTLETT has given the University of Chicago $125,000 for a gymnasium as a memorial of his son who died on July 15th.

A COLLECTION of eight hundred Arabic manuscripts, made by Count Landberg and said to be worth $20,000, has been presented to Yale University by Mr. Morris K. Jesup of the American Museum of Natural History.

THE trustees of the College of the City of New York are considering the lengthening of the course to seven years. They have asked that the appropriation made by the Board of Estimate and Apportionment last year be increased from $200,000 to $225,000. It is expected that the new buildings in 138th Street will be begun during the present autumn.

THE new president of the University of Rochester, Rev. Rush Rhees, who was elected last June, has assumed control, and his formal installation will take place on October 11th. President Seth Low, of Columbia University, will deliver an address on 'The City and the University'; President Harper, of the University of Chicago, will speak on 'The College Officer and the College Student'; President Seelye, of Smith College, will speak on 'Limitations to the President's Power in the American College.'

THE London *Educational Times* states that during the coming session evening science courses will be held in connection with the Technical Education Board at University College, King's College and Bedford College. At University College Professor J. A. Fleming, F.R.S., will give a course of ten lectures, followed by laboratory practice, in advanced electrical measurements. A course of lectures on the electric motor and its application to electric traction will be given by Professor C. A. Carus-Wilson, each lecture to be followed by an experimental demonstration or by a class for the practical working of numerical examples in connection with the subject. A course will be given by Professor E. Wilson at King's College on direct and alternating currents. In mechanical engineering, Professor T. Hudson Beare will give a course of ten lectures at University College, on the theory of steam engines and boilers, with laboratory work on the testing of steam engines and boilers. Professor Beare will also give a course of five lectures on the theory of gas and oil engines, combined with laboratory work.

DAVID J. BREWER, Associate Justice of the United States Supreme Court, has accepted the position of lecturer on the responsibilities of citizenship at Yale University. The lectures will be delivered next February.

PROFESSOR GOSS, who has for a number of years been professor of mechanical engineering and director of the mechanical laboratory in Purdue University, Lafayette, Ind., has been made dean of the Engineering Schools of the University.

PROFESSOR L. C. GLEN, of South Carolina College, has been appointed professor of geology at Vanderbilt University.

J. R. STREET, Ph.D. (Clark), has been appointed professor of pedagogy at Syracuse University.

MR. ALEXANDER MACPHAIL, M.B., C.M., senior demonstrator of anatomy in Glasgow University, has been appointed professor of anatomy in St. Mungo's College, Glasgow.

THE following promotions have been made in German universities: Dr. Wilhelm Authenrieth, of the University of Freiburg, has been appointed associate professor of pharmaceutical chemistry; Dr. R. Abegg, of the University of Breslau, associate professor of chemistry; Dr. A. Loewy, of the University of Berlin, professor of physiology; Dr. Osann, of the University at Bâsle, associate professor of geology and mineralogy; Dr. Paul Eisler and Dr. Vorländer, of the University at Halle, associate professors of anatomy and chemistry, respectively.

DR. JOSEPH ANTON GMEINER has qualified as docent in mathematics in the University of Vienna; Dr. Max Schwarzmann, as docent in mineralogy at the University of Giessen; Dr. Joseph Boleslaw Grzybowski, as docent in paleontology at the University of Cracow and Dr. Steinbrück as docent in agriculture at the University at Halle.

SCIENCE

FRIDAY, OCTOBER 5, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*THE NOBEL PRIZES FOR SCIENTIFIC DISCOVERIES.**

LAWS AND REGULATIONS.

THE three corporations awarding the Nobel prizes are:

1. The Royal Academy of Sciences, at Stockholm, founded in 1739. The King is the protector of the Academy, which numbers 100 Swedish and Norwegian members and 75 foreign members.

2. The Swedish Academy, at Stockholm, instituted in 1786. The King is the protector. The members, exclusively Swedish, are limited to 18.

3. The Carolin Institute of Medicine and Surgery, at Stockholm, established in 1815. The number of professors is 22.

OBJECT OF THE ENDOWMENT.

The Nobel endowment is based on the will of Dr. Alfred Bernhard Nobel, engineer, drawn up November 27, 1895. The stipulations are as follows:

"The remainder of the fortune which I shall leave shall be disposed of in the following manner: The capital, converted into safe investments by the executors of my will, shall constitute a fund the interest of which shall be distributed annually as a reward to those who, in the course of the preceding year, shall have rendered the greatest services to humanity. The sum total shall be divided into five equal portions, assigned as follows:

"1. To the person having made the most important discovery or invention iu the department of physical science.

"2. To the person having made the most important discovery or having produced the greatest improvement in chemistry.

* Summary received by the Department of State from the legation of Sweden and Norway, dated Washington, September 11, 1900, inclosing copy (in French) of the laws and regulations relating to the Nobel bequest.

"3. To the author of the most important discovery in the department of physiology or of medicine.

"4. To the author having produced the most notable literary work in the sense of idealism.

"5. To the person having done the most, or the best, in the work of establishing the brotherhood of nations, for the suppression or the reduction of standing armies, as well as for the formation and the propagation of peace conferences.

"The prizes will be awarded as follows: For physical science and chemistry, by the Swedish Academy of Sciences; for works in physiology or medicine, by the Carolin Institute of Stockholm; for literature, by the Academy of Stockholm; finally, for the work of peace, by a committee of five members, elected by the Norwegian Stortung. It is my expressed will that nationality shall not be considered, so that the prize may accrue to the most worthy, whether he be a Scandinavian or not."

The testamentary stipulations above cited serve as a basis for the regulations relating to the Nobel endowment, together with the explanations and the more detailed provisions contained in the present law, as well as in the deed of compromise, amicably brought about June 5, 1898, with certain of the heirs of the testator, and according to which the said heirs, after an agreement concluded on the subject of a less important portion of the property left by Dr. Nobel, declared that they accepted the will of Dr. Nobel and renounced in all contingencies, for themselves and for their descendants, all claim for the remainder of the succession of the said Dr. Nobel and all share in the administration of the legacy; they abandoned also all right to protest against the interpretations or additions to the will or other limitations relative to its execution, and to the employment of the capital which might be now, or in the future, made by decision of the King or by competent authorities. The following reservations are, however, expressly stipulated:

a. That the common law for all the authorities charged with the distribution of the prizes, and governing the manner and the conditions of the distribution, prescribed by the will, must be drawn up by common consent with a representative delegated by the family of Robert Nobel and submitted to the approval of the King.

b. That the following principles cannot be deviated from, viz:

1. That each of the annual prizes established by the will must be awarded at least once in the course of every period of five years, commencing with the year immediately following that in which the Nobel endowment shall enter on its functions, and that the sum total of a prize thus awarded shall in no case be less than 60 per cent. of the part of the yearly revenues disposable for the distribution of the prizes; neither can it be divided into more than three prizes at the most.

2. By the title 'Academy of Stockholm' written in the will is understood the Swedish Academy.

By the word 'literature' must be understood not only works purely literary, but also any other writing possessing by its form and its style a literary value. The limitation of the will declaring that the annual distribution of prizes must be directed to works executed 'in the course of the preceding year' must be interpreted in this sense, that the objects of the rewards shall be the most recent results of research displayed in the departments indicated by the will; older works will be considered only in the event that their importance shall have been demonstrated in recent times.

3. In order to be admitted to the competition, every written work must have been published by means of the press.

4. The sum total of a prize may be divided equally between two works, if it be judged that each of them has merited the prize. If the work rewarded is the work of two or of several assistants, the prize can be awarded to them in common. Any work the author of which is deceased can not be the object of a prize; however, in case of death after the proposal for a reward has already been presented in the prescribed forms, the prize may be awarded. Each one of the corporations having the conferring of prizes has the right to decide whether the prize may be adjudged to an institution or to a society.

5. According to the plain intention of the will, a work can not be rewarded unless experience or a competent examination shall prove its preponderant importance. If none of the works submitted to the competition possesses the quality desired, the sum total of the prize is reserved for the following year. If, then, the prize can not be distributed, the amount is deposited in the principal funds, unless three-fourths of the persons voting shall decide to establish with it a special fund for the section. The revenues of such a fund may, according to the decision of the corporation, be employed to encourage, otherwise than by the distribution of prizes, the tendencies aimed at in the first place by the donor. Each special fund will be administered with the principal fund.

6. For each section of Swedish prize, the competent corporation shall designate a 'Nobel committee,' composed of three or five members, who shall give their advice upon the conferring of the prize. The necessary examination for the awarding of the peace prize shall be made by the committee of the Norwegian Stortung mentioned in the will. In order to be named a member of a Nobel committee, it is not necessary to be a Swedish subject nor to belong to the corporation charged with the conferring of the prize. The members of a Nobel committee can receive a suitable fee for their work, which will be determined by the competent corporation. In a special case, if it is judged necessary, the corporation can designate a competent person to take part as a member in the deliberations and in the decisions of the Nobel committee.

7. For admission to the competition, it is necessary to be proposed in writing by a qualified person. No attention will be paid to requests addressed by persons desiring to obtain a prize themselves. It is explained further on who are considered qualified. The annual competition considers proposals which have been offered in the course of the year immediately preceding up to the date of February 1st.

8. Every proposal must be accompanied by the writings and other documents upon which it is founded. If the proposal is not drawn up in either one of the Scandinavian languages or in English, French, German or Latin, or if, for the appreciation of the proposed work, the body having to award the prize finds itself, for the most part, obliged to take cognizance of a writing composed in a language whose interpretation would cause special difficulties or considerable expense—in either of these cases, the corporation will not be obliged to proceed to a detailed examination of the proposal.

9. At the solemn reunion, which takes place on the anniversary of the death of the donor, December 10th, the corporations will make known publicly their decisions and bestow upon each laureate a check for the value of the prize, a diploma, and a gold medal bearing the effigy of the donor, with an appropriate legend. The laureate is obliged, unless prevented, to give during the six months following the reunion a public lecture on the subject of the work crowned. This lecture will be given in Stockholm, or, for the peace prize, in Christiania.

10. Decisions in regard to the awarding of prizes are without appeal. It is forbidden to insert a difference of opinion in the procès verbal, or to reveal it in any other manner.

11. Corporations have the right to establish scientific institutions and other establishments, in order to secure assistance for the examination which must precede the distribution of the prizes, and to serve, from other points of view, the aim of the endowment. These institutes and establishments, which form part of the endowment, shall be called 'Nobel institutes.'

12. Every Nobel institute is placed under the direction of the body which founded it. They are independent as regards their exterior situation and their finances; consequently, their revenues cannot be utilized by the corporations awarding the prizes, nor by any other institution to cover the expenses of their private budgets. Professors having a fixed salary in a Nobel institute can not hold a like position at the same time in any other institution, unless by special authorization of the King. Corporations may install Nobel institutes on a common site, giving them a uniform organization; they can attach foreigners, men and women, to the institute.

13. One-fourth of the revenues of the principal fund, which each section disposes of annually, is reserved. After the payment of the immediate expenses for the distribution of the prizes, the rest of the amount reserved is employed in defraying the expenses of the Nobel institute in each section. The balance, after paying the expenses of the year, is set aside for the future needs of the institute.

MANAGEMENT OF THE ENDOWMENT FUND.

The board of administration is composed of five Swedish members, one of whom—the president—is named by the King; the others are chosen by representatives of the corporations. The managing director is chosen by the board from among its own members. Members and substitutes are elected for a term of two years, commencing May 1st. The board of administration manages the endowment fund and all property common to the sections, pays the prizes and the expenses attendant on their distribution, the expenses of the Nobel institutes, engages all employees, determines the amount of their appointments and of their pensions; is empowered to appoint proxies, to prosecute and to answer, to plead and to act in the name of the endowment. The corporations awarding the prizes appoint fifteen representatives for two civil years. The Academy of Sciences chooses six and designates four substitutes; the other corporations each appoint three, with two substitutes. The representatives, called together by the oldest representative of the Academy of Sciences, elect one of their number as president. Nine votes, at least, are necessary to make a decision. A corporation failing to send representatives does not prevent the others from acting. The management and accounts of the board are examined every civil year by five examiners; each corporation appoints one, the King naming the fifth, who acts as president. The report upon the management must be given to the president before the end of February. The examiners must present their report to the representatives of the corporations before April 1st. This report, giving a résumé of the employment of the different funds, will be published in the newspapers. The failure of any corporation to appoint an examiner, or of an examiner to act, does not prevent the other members from proceeding with the examination. Examiners, and also the head of the Department of Public Instruction and Worship, have free access to all books, accounts and documents of the endowment.

All the investments of the fund must be examined and verified at least once a year. The representatives of the corporations have the right to decide, after the report of the examiners, whether the board of administration or any one of its members shall be discharged, or any other action taken against them. The King determines the salary of the managing director. The tenth part of the yearly net income of the principal fund is added to the capital; the interest of the sum destined for the prizes is added to the same fund until the distribution in prizes or otherwise.

TRANSIENT PROVISIONS.

Immediately after the approval of the King of the statute of endowment, the corporations will designate the stipulated number of representatives, who will assemble at Stockholm and elect the members of the board of administration, who will have the management of the endowment fund at the beginning of the year 1901. The executors of the will will take appropriate measures to terminate the settlement of the succession. The first distribution of prizes for all sections will take place, if possible, in 1901. From the endowment resources will be deducted: First, a sum of 300,000 crowns ($80,000) for each section—that is, 1,500,000 crowns ($402,000) in all—which, with the interest commencing from the 1st of January, 1900, will be used to cover, in proportion, the expenses of the organization of the Nobel institutes in addition to the sum the board of administration shall judge necessary for the acquisition of a special site destined for the administration of the endowment and including a hall for its meetings.

SPECIAL RULE GOVERNING THE AWARDING OF THE NOBEL PRIZES BY THE ACADEMY OF SCIENCES, ETC.

The right of presenting proposals for prizes belongs to—

1. Native and foreign members of the Royal Academy of Sciences.

2. Members of the Nobel committees for natural philosophy and chemistry.

3. Professors who have received the Nobel prize of the Academy of Science.

4. Ordinary and extraordinary professors of natural sciences and chemistry in the universities of Upsal, Lund, Christiania, Copenhagen and Helsingförs, in the Carolin Institute of Medicine and Surgery, the Superior Technical Royal School, as well as to the professors of the same sciences in the Stockholm High School.

5. Incumbents of corresponding chairs of at least six universities or high-schools, which the Academy of Science will select, taking care to divide them suitably between the different countries and their universities.

6. Learned men, to whom the Academy shall judge proper to send an invitation to this effect.

The invitations shall be sent every year in the month of September. Proposals for the prize must be made before February 1st of the following year. They are classified by the Nobel committee and submitted to the college of professors. The Nobel committee decides which of the works presented shall be submitted to a special examination. The college of professors will pronounce definitely on the distribution of the prize in the course of the month of October. The vote is taken in secret; if necessary, the question may be decided by drawing lots.

SPECIAL RULE GOVERNING THE AWARDING OF THE NOBEL PRIZE BY THE SWEDISH ACADEMY, ETC.

The right to present candidates for the Nobel prize belongs to the members of the Swedish Academy, the French Academy, and the Spanish Academy, which resembles the Swedish Academy in their organization and aim; to the members of the literary departments of other academies, as well as to the members of literary institutions and societies analogous to academies; to professors of æsthetics, of literature and of history in the universities. This order must be published at least every five years.

ADDRESS OF THE PRESIDENT OF THE ANTHROPOLOGICAL SECTION OF THE BRITISH ASSOCIATION.

Perhaps I ought to begin by apologizing for my conspicuous lack of qualification to fill this chair, but I prefer, with your permission, to dismiss that as a subject far too large for me to dispose of this morning. So I would beg to call your attention back for a moment to the excellent address given to this Section last year. It was full of practical suggestions which are well worth recalling: one was as to the project of a bureau of ethnology for Greater Britain, and another turned on the desirability of founding an imperial institution to represent our vast colonial empire. I mention these in the hope that we shall not leave the government and others concerned any peace till we have realized those modest dreams of enlightenment. People's minds are just now so full of other things that the interests of knowledge and science are in no little danger of being overlooked. So it is all the more desirable that the British Association, as our great parliament of science, should take the necessary steps to prevent that happening, and to keep steadily before the public the duties which a great and composite nation like ours owes to the world and to humanity, whether civilized or savage.

The difficulties of the position of the president of this Section arise in a great measure from the vastness of the field of research which the Science of Man covers. He is, therefore, constrained to limit his attention as a rule to some small corner of it; and, with the audacity of ignorance, I have selected that which might be labeled the early ethnology of the British Isles, but I propose to approach it only along the precarious paths of folklore and philology, because I know no other. Here, however, comes a personal difficulty; at any rate, I suppose I ought to pretend that I feel it a difficulty, namely, that I have committed myself to publicity on that subject already. But as a matter of fact, I can hardly bring myself to confess to any such feeling; and this leads me to mention, in passing, the change of attitude which I have lived to notice in the case of students in my own position. Most of us here present have known men who, when they had once printed their views on their favorite subjects of study, stuck to those views through thick and thin, or at most limited themselves to changing the place of a comma here and there, or replacing an occasional *and* by a *but*. The work had then been made perfect, and not a few great questions affecting no inconsiderable portions of the universe had been forever set at rest. That was briefly the process of getting ready for posterity, but one of its disadvantages was that those who adopted it had to waste a good deal of time in the daily practice of the art of fencing and winning verbal victories; for, metaphorically speaking,

> 'With many a whack and many a bang
> Rough crab-tree and old iron rang.'

Now all that, however amusing it may have been, has been changed, and what now happens is somewhat as follows: AB makes an experiment or propounds what he calls a working hypothesis; but no sooner has AB done so than CD, who is engaged in the same sort of research, proceeds to improve on AB. This, instead of impelling AB to rush after CD with all kinds of epithets and insinuating that his character is deficient in all the ordinary virtues of a man and a brother, only makes him go to work again and see whether he cannot improve on CD's results; and most likely he succeeds, for one discovery leads to another. So we have the spectacle not infrequently of a man illustrating the truth of the poet's belief,

'That men may rise on stepping-stones
Of their dead selves to higher things.'

It is a severe discipline in which all display of feeling is considered bad form. Of course every now and then a spirit of the ruder kind discards the rules of the game and attracts attention by having public fits of bad temper; but generally speaking, the rivalry goes on quietly enough to the verge of monotony, with the net result that the stock of knowledge is increased. I may be told, however, that while this kind of exercise may be agreeable to the ass who writes, it is not conducive to the safety of the publisher's chickens. To that it might suffice to answer that the publisher is usually one who is well able to take good care of his chickens; but, seriously, what it would probably mean is, that in the matter of the more progressive branches of study, smaller editions of the books dealing with them would be required, but a more frequent issue of improved editions of them, or else new books altogether, a state of things to which the publisher would probably find ways of adapting himself without any loss of profits. And after all, the interests of knowledge must be reckoned uppermost. It is needless to say that I have in view only a class of books which literary men proper do not admit to be literature at all; and the book trade has one of its main stays, no doubt, in books of pure literature, which are like the angels that neither marry nor give in marriage—they go on forever in their serene singleness of purpose to charm and chasten the reader's mind.

My predecessor last year alluded to an Oxford don said to have given it as his conviction that anthropology rests on a foundation of romance. I have no notion who that Oxford don may have been, but I am well aware that Oxford dons have sometimes a knack of using very striking language. In this case, however, I should be inclined to share to a certain extent that Oxford don's regard for romance, holding as I do that the facts of history are not the only facts deserving of careful study by the anthropologist. There are also the facts of fiction, and to some of those I would now call your attention. Recently, in putting together a volume on Welsh folklore, I had to try to classify and analyze in my mind the stories which have been current in Wales about the fairies. Now the mass of folklore about the fairies is of various origins. Thus with them have been more or less inseparably confounded certain divinities or demons, especially various kinds of beings associated with the rivers and lakes of the country. They are creations introduced from the worship of the imagination; then there is the dead ancestor, who also seems to have contributed his share to the sum total of our notions about the Little People. In far the greater number of cases, however, we seem to have something historical, or, at any rate, something which may be contemplated as historical. The key to the fairy idea is that there once was a real race of people to whom all kinds of attributes, possible and impossible, have been given in the course of uncounted centuries of story-telling by races endowed with a lively imagination.

When the mortal midwife has been fetched to attend on a fairy mother in a fairy palace, she is handed an ointment which she is to apply to the fairy baby's eyes, at the same time that she is gravely warned not to touch her own eyes with it. Of course any one could foresee that when she is engaged in applying the ointment to the young fairy's eyes one of her own eyes is certain to itch and have the benefit of the forbidden salve. When this happens the midwife has two very different views of her surroundings: with the untouched eye she sees that she is in the finest and grandest place that she has ever beheld in her life, and there she can see the lady on whom she is attending reposing on a bed, while with the anointed eye she perceives how she is lying on a bundle of rushes and withered ferns in a large cave, with big stones all around her and a little fire in one corner, and she also discovers that the woman is a girl who has once been her servant. Like the midwife, we have also to exercise a sort of double vision if we are to understand the fairies and see through the stories about them. An instance will explain what I mean: Fairy women are pretty generally represented as fascinating to the last degree and gorgeously dressed; that is how they appear through the glamor in which they move and have their being. On the other hand, not only are some tribes of some fairies described as ugly, but fairy children when left as changelings are invariably pictured as repulsive urchins of a sallow complexion and mostly deformed about the feet and legs; there we have the real fairy with the glamor taken off and a certain amount of depreciatory exaggeration put on.

Now when one approaches the fairy question in this kind of way, one is forced, it strikes me, to conclude that the fairies, as a real people, consisted of a short, stumpy, swarthy race, which made its habitations underground or otherwise cunningly concealed. They were hunters, probably, and fishermen; at any rate, they were not tillers of the ground or eaters of bread. Most likely they had some of the domestic animals and lived mainly on milk and the produce of the chase, together with what they got by stealing. They seem to have practiced the art of spinning, though they do not appear to have thought much of clothing. They had no tools or implements made of metal. They appear to have had a language of their own, which would imply a time when they understood no other, and explain why, when they came to a town to do their marketing, they laid down the exact money without uttering a syllable to anybody by way of bargaining for their purchases. They counted by fives and only dealt in the simplest of numbers. They were inordinately fond of music and dancing. They had a marvelously quick sense of hearing, and they were consummate thieves; but their thievery was not systematically resented, as their visits were held to bring luck and prosperity. More powerful races generally feared them as formidable magicians who knew the future and could cause or cure disease as they pleased. The fairies took pains to conceal their names no less than their abodes, and when the name happened to be discovered by strangers the bearer of it usually lost heart and considered himself beaten. Their family relations were of the lowest order; they not only reckoned no fathers, but it may be that, like certain Australian savages recently described by Spencer and Gillen, they had no notion of paternity at all. The stage of civilization in which fatherhood is of little or no account has left evidence of itself in Celtic literature, as I shall show presently; but the other and lower stage, anterior to the idea of fatherhood at all comes into sight only in certain bits of folklore, both Welsh and Irish, to the effect that the fairies were all women and girls. Where could such an idea have originated? Only, it seems to me, among a race once on a level with the native Australians to whom I have alluded, and of whom Frazer of 'the Golden Bough' wrote as follows in last year's *Fortnightly Review:* "Thus, in the opinion of these savages, every conception is what we are wont to call an immaculate conception, being brought about by the entrance into the mother of a spirit, apart from any contact with the other sex. Students of folklore have long been familiar with the notions of this sort occurring in the stories of the birth of miraculous personages, but this is the first case on record of a tribe who believe in immaculate conception as the sole cause of the birth of every human being who comes into the world. A people so ignorant of the most elementary of natural processes may well rank at the very bottom of the savage scale." Those are Dr. Frazer's words, and for a people in that stage of ignorance to have imagined a race all women seems logical and natural enough—but for no other. The direct conclusion, however, to be drawn from this argument is that some race—possibly more than one—which has contributed to the folklore about our fairies, has passed through the stage of ignorance just indicated; but as an indirect conclusion one would probably be right in supposing this race to have been no other than the very primitive one which has been exaggerated into fairies. At the same time it must be admitted that they could not have been singular always in this respect among the nations of antiquity, as is amply proved by the prevalence of legends about virgin mothers, to whom Frazer alludes, not to mention certain wild stories recorded by the naturalist Pliny concerning certain kinds of animals.

Some help to make out the real history of the Little People may be derived from the names given them, of which the most common in Welsh is that of *y Tylwyth Teg* or the Fair Family. But the word *cor*, 'a dwarf,' feminine *corres*, is also applied to them; and in Breton we have the same word with such derivatives as *korrik*, 'a fairy, a wee little wizard or sorcerer,' with a feminine *korrigan* or *korrigez*, analogously meaning a she-fairy or a diminutive witch. From *cor* we have in Welsh the name of a people, called the Coranians, figuring in a story in the fourteenth-century manuscript of the Red Book of Hergest. There one learns that the Coranians were such consummate magicians that they could hear every word that reached the wind, as it is put; so they could not be harmed. The name Coranians of those fairies has suggested to Welsh writers a similar explanation of the name of a real people of ancient Britain. I refer to the *Coritani*, whom Ptolemy located, roughly speaking, between the river Trent and Norfolk, assigning to them the two towns of *Lindum* (Lincoln) and *Ratæ*, supposed to have been approximately where Leicester now stands. It looks as if all invaders from the Continent had avoided the coast from Norfolk up to the neighborhood of the Humber, for the good reason, probably, that it afforded very few inviting landing-places. So here presumably the ancient inhabitants may have survived in sufficient numbers to have been called by their neighbors of a different race 'the dwarfs,' or *Coritani*, as late as Ptolemy's time in the second century. This harmonizes with the fact that the Coritani are not mentioned as doing anything, all political initiative having long before probably passed out of their hands into those of a more powerful race. How far inland the Coritanian territory extended it is impossible to say, but it may have embraced the northern half of Northamptonshire, where we have a place-name *Pytchley*, from an earlier *Pihtes lêa*, meaning 'The Pict's Meadow,' or else the meadow of a man called Pict. At all events, their country took in the few districts containing Croyland, where towards the end of the seventh century St. Guthlac set up his cell on the side of an ancient tumulus and was disturbed by demons that talked Welsh. Certain portions of the Coritanian country offered, as one may infer, special advantages as a home for retreating nationalities : witness as late as the eleventh century the resistance offered by Hereward in the Isle of Ely to the Norman Conqueror and his mail-clad warriors.

In reasoning backwards from the stories about the Little People to a race in some respects on a level with Australian savages, we come probably in contact with one of the very earliest populations of these islands. It is needless to say that we have no data to ascertain how long that occupation may have been uncontested, if at all, or what progress was made in the course of it : perhaps archeology will be able some day to help us to form a guess on that subject. But the question more immediately pressing for answer is, with what race outside Wales may one compare or identify the ancient stock caricatured in Welsh fairy tales? Now, in the Lowlands of Scotland, together with the Orkneys and Shetlands, the place of our fairies is to some extent taken by the Picts, or, as they are there colloquially called, 'the Pechts.' My information about the Pechts comes mostly from recent writings on the subject by Mr. David MacRitchie, of Edinburgh, from whom one learns, among other things, that certain underground—or partially underground—habitations in Scotland are ascribed to the Pechts. Now one kind of these Pechts' dwellings appears from the outside like hillocks covered with grass, so as presumably not to attract attention, an object which was further helped by making the entrance very low and as inconspicuous as possible. But one of the most remarkable things about them is the fact that the cells or apartments into which they are divided are frequently so small that their inmates must have been of very short stature, like our Welsh fairies. Thus, though there appears to be no reason for regarding the northern Picts themselves as an undersized race, there must have been a people of that description in their country. Perhaps archeologists may succeed in classifying the ancient habitations in the North accordingly — that is, to tell us what class of them were built by the Picts and what by the Little People whom they may be supposed to have found in possession of that part of our island.

In Ireland and the Highlands of Scotland the fairies derive their more usual appellations from a word *síd* or *síth* (genitive *síde*), which may perhaps be akin to the Latin *sēdes* and have meant a seat, settlement, or station ; but whatever its exact meaning may have originally been, it came to be applied to the hillocks or mounds within which the Little People made their abodes. Thus, *Aes Síde* as a name for the fairies may be rendered by mound people or hill folk ; *fer síde*, 'a fairy man,' by a mound man ; and *ben síde* by a mound woman or banshee. They were also called simply *síde*, which would seem to be an adjective closely allied with the simpler word *síd*.

But to leave this question of their names, let me direct your attention for a moment to one of the most famous kings of the fairies of ancient Erin : he was called Mider of Brí Leith, said to be a hill to the west of Ardagh, in the present county of Longford. There he had his mound, to which he once carried the queen of Eochaid Airem, monarch of Ireland. It was some time before Eochaid could discover what had become of her, and he ordered Dálan, his druid, to find it out. So the druid, when he had been unsuccessful for a whole year, prepared four twigs of yew and wrote on them in Ogam. Then it was revealed to him through his keys of seership and through the Ogam writing that the queen was in the *síd* of Brí Leith, having been taken thither by Mider. By this we are probably to understand that the druid sent forth the Ogam twigs as letters of enquiry to other druids in different parts of the country ; but in any case he was at last successful, and his king hurried at the head of an army to Brí Leith, where they began in earnest to demolish Mider's mound. At this Mider was so frightened that he sent the queen forth to her husband, who then departed, leaving the fairies to digest their wrath; for it is characteristic of them that they did not fight, but bided their time for revenge, which in this case did not come till long after Eochaid's day. Now, with regard to the fairy king, one is not told, so far as I can call to mind, that he was a dwarf, but the dwarfs were not far off; for we read of an Irish satirist who is represented as notorious for his stinginess; and, to emphasize the description of his inhospitable habits, he is said to have taken from Mider three of his dwarfs and stationed them around his own house, in order that their truculent looks and rude words might repel any of the men of Erin who might come seeking hospitality or bringing any inconvenient request. The word used for dwarf in this story is *corr*, which is usually the Irish for a crane or heron, but here, and in some other instances, which I cannot now discuss, it seems to have been identical with the Brythonic *cor*, 'a dwarf.' It is remarkable, moreover, that the rôle assigned to the three Irish *corrs* is much the same as that of the dwarf of Edeyrn son of Nudd, in the Welsh story of *Geraint and Enid* and Chrétien de Troies' *Erec*, which characterizes him as *fel et de put'eire*, 'treacherous and of an evil kind.'

By way of summarizing these notes on the Mound Folk I may say that I should regard them as isolated and wretched remnants of a widely spread race possessing no political significance whatsoever. But, with the inconsistency characteristic of everything connected with the fairies, one has, on the other hand, to admit that this strange people seems to have exercised on the Celts—probably on other races as well—a sort of permanent spell of mysteriousness and awe stretching to the verge of adoration. In fact, Irish literature states that the pagan tribes of Eriu before the advent of St. Patrick used to worship the *síde* or the fairies. Lastly, the Celt's faculty of exaggeration, combined with his incapacity to comprehend the weird and uncanny population of the mounds and caves of his country, has enabled him, in one way or another, to bequeath to the great literatures of Western Europe a motley train of dwarfs and little people, a whole world of wizardry, and a vast wealth of utopianism. If you subtracted from English literature, for example, all that has been contributed to its vast stores from this native source, you would find that you left a wide and unwelcome void.

But the question must present itself sooner or later, with what race outside these islands we are to compare or identify our mound-dwellers. I am not prepared to answer, and I am disposed to ask our archeologists what they think. In the meantime, however, I may say that there are several considerations which impel me to think of the Lapps of the North of Europe. But even supposing an identity of origin were to be made out as between our ancient mound-inhabiting race and the Lapps, it would remain still doubtful whether we could expect any linguistic help from Lapland. The Lapps now speak a language belonging to the Ugro-Finnic family, but the Lapps are not of the same race as the Finns; so it is possible that the Lapps have adopted a Finnish language and that they did so too late for their present language to help us with regard to any of our linguistic difficulties. One of these lies in our topography: take, for instance, only the names of our rivers and brooks—there is probably no county in the kingdom that would be too small to supply a dozen or two which would baffle the cleverest Aryan etymologist you could invite to explain them; and why? Because they belong in all probability to a non-Celtic, non-Aryan language of some race that had early possession of our islands. Nevertheless, it is very desirable that we should have full lists of such names, so as to see which of them recur and where. It is a subject deserving the attention of this Section of the British Association.

We have now loitered long enough in the gloom of the Pict's house. Let us leave the glamor of the fairies and see whether any other race has had a footing in these islands before the coming of the Celts. In August, 1891, Professor Sayce and I spent some fine days together in Kerry and other parts of the southwest of Ireland. He was then full of his visits to North Africa, and he used to assure me that, if a number of Berbers from the mountains had been transferred to a village in Kerry and clad as Irishmen, he would not have been able to tell them by their looks from native Irishmen such as we saw in the course of our excursions. This seemed to me at the time all the more remarkable as his reference was to fairly tall blue-eyed persons whose hair was rather brown than black. Evidence to the same effect might now be cited in detail from Professor Haddon and his friends' researches among the population of the Arran Islands in Galway Bay. Such is one side of the question which I have in my mind; the other side consists in the fact that the Celtic languages of to-day have been subjected to some disturbing influence which has made their syntax unlike that of the other Aryan languages. I have long been of opinion that the racial interpretation of that fact must be that the Celts of our islands have assimilated another race, using a language of its own, in which the syntactical peculiarities of Neo-Celtic had their origin; in fact, that some such race clothed its idioms in the vocabulary which it acquired from the Celts. The problem then was to correlate those two facts. I am happy to say this has now been undertaken from the language point of view by Professor J. Morris Jones, of the University College of North Wales. The results have been made public in a book on 'The Welsh People' recently published by Mr. Fisher Unwin. The paper is entitled 'Pre-Celtic Syntax in Insular Celtic,' and the languages which have therein been compared with Celtic are old Egyptian and certain dialects of Berber. It is all so recent that we have as yet had no criticism, but the reasoning is so sound and the arguments are of so cumulative a nature, that I see no reason to anticipate that the professor's conclusions are in any danger of being overthrown.

At the close of his linguistic argument, Professor Morris Jones quotes a French authority to the effect that when a Berber king dies or is deposed, which seems to happen often enough, it is not his son that is called to succeed him, but the son of his sister, as appears to have been usual among certain ancient peoples of this country; but of this more anon. In the next place, my attention has been called by Professor Sayce to the fact that ancient Egyptian monuments represent the Libyans of North Africa with their bodies tattooed, and that even now some of the Touaregs and Kabyles do the same. These indications help one to group the ancient peoples of the British Isles to whose influence we are to ascribe the non-Aryan features of Neo-Celtic. In the first place, one cannot avoid fixing on the Picts, who were so called because of their habit of tattooing themselves. For as to that fact there seems to be no room for doubt, and Mr. Nicholson justly lays stress on the testimony of the Greek historian Herodian, who lived in the time of Severus, and wrote about the latter's expedition against the natives of North Britain a long time before the term *Picti* appears in literature. For Herodian, after saying that they went naked, writes about them to the following effect: "They puncture their bodies with colored designs and the figures of animals of all kinds, and it is for this reason that they do not wear clothes, lest one should not behold the designs on their bodies." This is borne out by the names by which the Picts have been known to the Celts. That of *Pict* is itself in point, and I shall have something to say of it presently; but one of the other names was in Irish, *Cruithni,* and in Welsh we have its etymological equivalent in *Prydyn* or *Prydain.* These vocables are derived respectively from Irish *cruth* and Welsh *pryd*, both meaning shape, form or figure, and it is an old surmise that the Picts were called by those names in allusion to the animal forms pricked on their bodies as described by Herodian and others. The earlier attested of these two names may be said to be Prydyn or Prydain, which the Welsh used to give in the Middle Ages to the Picts and the Pictland of the North, while the term *Ynys Prydain* was retained for Great Britain as a whole, the literal meaning being the Island of the Picts; that is the only name which we have in Welsh to this day for this island in which we live—*Ynys Prydain*, 'The Picts' Island.' Now one detects this word Prydain in effect in the Greek *Πρετανικαί Νῆσοι* given collectively to all the British Isles by ancient authors, such as Strabo and Diodorus. It may be rendered the Pictish Islands, but a confusion seems to have set in pretty early with the name of the Brittanni or Brittones of South Britain; that is to say, *Pretanic*, 'Pictish,' became *Brittannic* or British; and this is, historically speaking, the only known justification we have for iucluding Ireland in the comprehensive term 'The British Isles,' to which Irishmen are sometimes found jocularly to object.

In the next place may be mentioned the Tuatha Dé Danann of Irish legend, who cannot always be distinguished from the Picts, as pointed out by Mr. MacRitchie. The tradition about them is that, when they were overcome in war by Míl and his Milesians, they gave up their life aboveground and retired into the hills like the fairies, a story of little more value than that of the extermination of the Picts of Scotland. In both countries doubtless the more ancient race survived to amalgamate with its conquerors. There was probably some amount of amalgamation between the Tüatha Dé Danann, or the Picts, and the Little Moundsmen; but it is necessary not to confound them. The Tuatha shared with the Little People a great reputation for magic; but they differed from them in not being dwarfs or of a swarthy complexion; they are usually represented as fair. In the case of Mider the fairy king, who comes in some respects near the description of the heroes of the Tuatha Dé Danann, it is to be noticed that he was a wizard, not a warrior.

Guided by the kinship of the name of the Tuatha Dé *Danann* on the Irish side of the sea and that of the Sons of *Dôn* on this side, I may mention that the Mabinogion place the Sons of Dôn on the seaboard of North Wales, in what is now Carnarvonshire; more precisely their country was the region extending from the mountains to the sea, especially opposite Anglesey. In that district we have at least three great prehistoric sites, all on the coast. First comes the great stronghold on the top of Penmaen Mawr; then we have the huge mound of Dinas Dinlle, eaten into at present by the sea southwest of the western mouth of the Menai Straits; and lastly there is the extensive fortification of Tre'r Ceiri, overlooking Dinlle from the heights of the Eifl. By its position Tre'r Ceiri belonged to the Sons of Dôn, and by its name it seems to me to belong to the Picts, which comes, I believe, to the same thing. Now the name

Tre'r Ceiri means the town of the Keiri, and the Welsh word *ceiri* is used in the district in the sense of persons who are boastful and ostentatious, especially in the matter of personal appearance and fine clothing. It is sometimes also confounded with *cewri*, 'giants,' but in the name of Tre'r Ceiri it doubtless wafts down to us an echo of the personal conceit of the ancient Picts with their skins tattooed with decorative pictures; and Welsh literature supplies a parallel to the name *Ynys Prydain* in one which is found written *Ynys y Ceuri*, both of which may be rendered equally the Island of the Picts, but more literally perhaps some such rendering as 'the Island of the Fine Men' would more nearly hit the mark. Lastly, with the Sons of Dôn must probably be classed the other peoples of the Mabinogion, such as the families of Llyr, and of Pwyll and Rhiannon.

All these peoples of Britain and Ireland were warlike, and such, so far as one can see, that the Celts, who arrived later, might with them form one mixed people with a mixed language, such as Professor Morris Jones has been helping to account for.

Let us now see for a moment how what we read of the state of society implied in the stories of the Mabinogion will fit into the hypothesis which I have roughly sketched. In the first place, I ought to explain that the four stories of the Mabinogion were probably put together originally in the Goidelic of Wales before they assumed a Brythonic dress. Further, in the form in which we know them, they have passed through the hands of a scribe or editor living in Norman times, who does not always appear to have understood the text on which he was operating. To make out, therefore, what the original Mabinogion meant, one has every now and then to read, so to say, between the lines. Let us take, for example, the Mabinogi called after Branwen, daughter of Llyr. She was sister to Brân, king of Prydain, and to Manawyddan, his brother: she was given to wife to an Irish king named Matholwch, by whom she had a son called Gwern. In Ireland, however, she was after a time disgraced, and served in somewhat the same way as the heroine of the Gudrun Lay; but in the course of the time which she spent in a menial position, doing the baking for the Court and having a box on the ear administered to her daily by the cook, she succeeded in rearing a starling, which one day carried a letter from her to her brother Brân at Harlech. When the latter realized his sister's position of disgrace, he headed an expedition to Ireland, whereupon Matholwch tried to appease him by making a concession, which was that he should deliver his kingdom to the boy Gwern. Now the question is, wherein did the concession consist? The redactor of the Mabinogi could, seemingly, not have answered, and he has not made it the easier for any one else to answer. In the first place, instead of calling Gwern son of Matholwch, he should have called him Gwern son of Branwen, after his mother, for the key to the sense is that, in a society which reckoned birth alone, Gwern was not recognized as any relation to Matholwch at all, whereas, being Brân's sister's son, he was Brân's rightful heir. No such idea, however, was present to the mind of a twelfth-century scribe, nor could it be expected.

Let us now turn to Irish literature, to wit, to one of the many stories associated with the hero Cúchulainn. He belonged to Ulster, and whatever other race may have been in that part of Ireland, there were Picts there: as a mater of fact, Pictish communities survived there in historical times. Now Cúchulainn was not wholly of the same race as the Ultonians around him, for he and his father are sharply marked off from all the other Ultonians as being free from the periodical illness connected with what has been called the couvade, to which the other adult braves of Ulster succumbed for a time every year. Then I may mention that Cúchulainn's baby name was *Setanta Beg*, or the Little Setantian, which points to the country whence Cúchulainn's father had probably come, namely the district where Ptolemy mentions a harbor of the Setantii, somewhere near the mouth of the Ribble, in what is now Lancashire. At the time alluded to in the story I have in view, Cúchulainn was young and single, but he was even then a great warrior, and the ladies of Ulster readily fell in love with him; so one day the nobles of that country met to consider what was to be done, and they agreed that Cúchulainn would cause them less anxiety if they could find him a woman who should be his fitting and special consort. At the same time also that they feared he might die young, they were desirous that he should leave an heir, 'for,' as it is put in the story, 'they knew that it was from himself his rebirth would be.' The Ulster men had a belief, you see, in the return of the heroes of previous generations to be born again; but we have here two social systems face to face. According to the one to which Cúchulainn as a Celt belonged, it was requisite that he should be the father of recognized offspring, for it was only in the person of one of them or of their descendants that he was to be expected back. The story reads as if the distinction was exceptional, and as if the prevailing state of things was wives more or less in common, with descent reckoned according to birth alone. Such is my impression of the picture of the society forming the background to the state of things implied by the conversation attributed to the noblemen of Ulster. Here again one experiences difficulties arising from the fact that the stories have been built up in the form in which we know them by men who worked from the Christian point of view, and it is only by scrutinizing, as it were, the chinks and cracks that you can faintly realize what the original structure was like.

Among other aids to that end one must reckon the instances of men being designated with the help of the mother's name, not the father's; witness that of the King of Ulster in Cúchulainn's time, namely, Conchobar mac Nessa, that is to say, Conor, son of a mother named Nessa; similarly in Wales with Gwydion son of Dôn. Further we have the help of a considerable number of ancient inscriptions, roughly guessed to date from the fifth or the sixth century of our era, and commemorating persons traced back to a family group of the kind, perhaps, which Cæsar mentions in the fourteenth chapter of his fifth book. Within these groups the wives were, according to him, in common (*inter se communes*). Take, for instance, an inscription from the barony of Corcaguiny in Kerry, which commemorates a man described as 'Mac Erce, son of *Muco Dovvinias*,' where *Muco Dovvinias* means the clan or family group of *Dovvinis* or *Dubin* (genitive *Duibne*), the ancestress after whom Corcaguiny is called *Corco-Duibne* in Medieval Irish. We have the same formula in the rest of Ireland, including Ulster, where as yet very few Ogams have been found at all. It occurs in South Wales and in Devonshire, and also on the Ogam stone found at Silchester in Hampshire. The same kind of family group is evidenced also by an inscription at St. Ninian's, in Galloway; and, to go further back—perhaps a good deal further back—we come to the bronze discovered not long ago at Colchester, and dating from the time of the Emperor Alexander Severus, who reigned from 222 to 235. This is a votive tablet to a god Mars Medocius, by a Caledonian Pict, who gives his name as Lossio Veda, and describes himself further as *Nepos Vepogeni Caledo.* He alludes to no father, and *Nepos Vepogen* is probably to be rendered Vepogen's sister's son. At any rate, the Irish word corresponding etymologically to the Latin *nepos* has that sense in Irish; but so far as I know it has never been found meaning a nephew in the sense of brother's son. That may serve as an instance how the ideas of another race penetrated the fabric of Goidelic society; for here we must suppose a time to have come when there was no longer any occasion for a word meaning a brother's son, which, of course, there never was in the non-Celtic society which ranked men and women according to their birth alone.

Now this Caledonian Pict was not exceptional among his kinsmen, for they succeeded in observing a good deal of silence concerning their fathers down, one may say, to the 12th century. It is historical that the king of the northern Picts was not wont to be the son of the previous king. In short, when the Celtic elements there proved strong enough to ensure that the son of a previous king should succeed, a split usually took place, the purer Picts being led by the rule of succession by birth to set up a king of their own. The fact is not so well known that the same succession prevailed also some time or other at Tara in Ireland; it is proved by a singular piece of indirect evidence, the existence of a tragic story to explain why 'no son should ever take the lordship of Tara after his father, unless some one came between them.' The last clause is due, I should say, to somebody who could not understand such a prohibition based on the ancient rule that a man's heir was his sister's son. This would be, according to Irish legend, in the lifetime of Conor mac Nessa.

It is curious to notice how the stories about the Pictish *ménage* seem to have puzzled ancient authors. I will only cite one instance, to wit, from Golding's 16th century translation of what then passed as the production of Solinus, and what may pass now, even according to Mommsen, as quite old enough for my present purpose. It runs thus: "From the Promontorie of *Calydon* to the Iland *Thule* is two dayes sayling. Next come the Iles called *Hebudes*, five in number, the inhabiters whereof know not what corne meaneth, but liue onely by fishe and milke. They are all vnder the gouernment of one King. For as manie of them as bee, they are seuered but with a narrowe groope one from another. The King hath nothing of hys own, but taketh of euery mans. He is bounde to equitie by certaine lawes: and least he may start from right through couetonsnesse, he learneth Justice by pouertie, as who may haue nothing proper or peculiar to himselfe, but is found at the charges of the Realme. Hee is not suffered to haue anie woman to himselfe, but whomsoeuer he hath minde vnto, he borroweth her for a tyme, and so others by turnes. Wherby it commeth to passe that he hath neither desire nor hope of issue."

The man who wrote in that way presumably failed to see that the king was not subject to any special hardship as compared with the other men in his kingdom, where none of them had any offspring that he could individually call his own. This, be it noticed, refers to the Hebrides, not, as sometimes happens, to the more distant island of Thule, where there was also a king, as any reader of 'Faust' will tell us.

We now come to the Celts, and begin with Pliny's version of Cæsar's words about the division of Gaul into three parts, as follows: *Gallia omnis Comata uno nomine appellata in tria populorum genera dividitur, amnibus maxime distincta. A Scalde ad Sequanam Belgica, ab eo ad Garunnam Celtica eademque Lugdunensis, inde ad Pyrenæi montis excursum Aquitanica, Aremorica antea dicta.* We may for the present dismiss the third or Aquitanic Gaul from our minds; but

Belgic and Celtican Gaul may be taken as representing the two sets of Celts of our own islands. The Belgic Gauls began last to come to this country, and their advent seems to fall between the visits of Pytheas and Julius Cæsar—that is, roughly speaking, between the middle of the fourth century and that of the first century B.C. In this country they came to be known collectively as Brittanni or Brittones, the linguistic ancestors of the peoples who have spoken Brythonic or the *Lingua Brittannica*, such as the Welsh, the Cornish, and the Strathclyde Britons. As to the other Celts, it is much harder to say when or whence exactly they came—I mean the linguistic ancestors of the Gaels of Ireland, Man, and Scotland—that is to say, the peoples whose language has been Goidelic. Some scholars are of opinion that there were no Goidelic-speaking peoples in Britain till some such came here from Ireland on sundry occasions, beginning with the second century, in the time of the Roman occupation, but how the Goidels would be supposed by them to have reached Ireland I do not exactly know. My own notion is that the bulk of them reached that country by way of Britain, and that they arrived in Britain, like the Belgic Gauls later, from the nearest parts of the Continent; for this would be previous to the appearance of the Belgic Gauls on the western seaboard of Europe; that is to say, at a time when Celtica extended not merely to the Seine, but to the Scheldt or to the Rhine, if not even further. Then as to the time of the coming of the ancestors of the Goidels, it has been supposed coincident with a period of great movements among the Celts of the Continent, in particular the movements which resulted, among other things, in some of them reaching the shores of the Mediterranean and penetrating to the heart of the Iberic peninsula. Perhaps one would not be far wrong in fixing on the seventh and the sixth centuries B.C. as covering the time of the coming of the earlier Celts to our shores.

In Britain I should suppose these earlier hordes of Celts to have conquered most of the southern half of the island; and the Brythonic Celts, when they arrived, may have overrun much the same area, pushing the Goidelic Celts more and more towards the west. Under that pressure it is natural to suppose that some of the latter made their way to Ireland, but it is quite possible that their emigration thither had begun before. Some time or other previous to the Roman occupation the Brythonic people of the Ordovices seem to have penetrated to the sea between the rivers Dovey and Mawddach, displacing probably some Goidels, who may have gone to the opposite coasts of Ireland; but more traces in Irish story appear of invasions on the part of the Dumnonii, who possessed the coast between Galloway and Argyle. These were so situated as to be able to assail Ireland both in front and from behind, and this is countenanced to some extent by Irish topography, not to mention the long legends extant as to great wars in the west of Ireland between the Tuatha Dé Danann and invaders including the Fir Domnann. I suspect also that it was the country of these northern Dumnonians which was originally meant by Lochlinn, a name interpreted later to mean Norway.

Such are some of the faint traces of the Goidelic invasions of Ireland from Britain, but it is possible—perhaps probable—that Ireland received settlers on its southern coast from the northwest of Gaul at a comparatively late period, at the time, let us say, when Cæsar was engaged in crushing the Veneti and the Aremoric League. This has been suggested to me by the name of the Usdiæ, which probably survives in the first syllable of *Ossory*, denoting a tract of country now, roughly speaking, covered by the county of Kilkenny, but which may have been considerably larger before the Déisi took possession of the baronies of the two Decies and other districts now constituting the county of Waterford, not to mention possible encroachments on the part of Munster on a boundary which seems to have been sometimes contested. Now the Continental name which invites comparison with that of the Usdiæ is that of the Ostiæi, who in the time of Pytheas appear to have occupied the northwestern end of what afterwards came to be called Brittany; they were also called Ostiones, and more commonly Osismi. I see no reason to suppose that the ships of the Aremoric League could not make the voyage from Brittany to the principal landing-places on the south of Ireland from the Harbor of Cork to that of Waterford, and I gather from Ptolemy's Geography that Ireland was relatively better known on the Continent than Britain, although the latter has been in a manner connected with the Roman world. This I should explain somewhat as follows: Cæsar, who knew very little about the west of Britain and probably less about Ireland, says that in his time the great druidic center of Gaul was in the country of the Carnutes, somewhere, let us say, near the site of the present town of Chartres, that druidism had been introduced from Britain to Gaul, and that those who wished to understand it had to go to Britain to study. The authors of antiquity tell us otherwise nothing about druids in Britain, except that Tacitus speaks of such in the Annals, in his well-known passage as to Suetonius Paulinus landing with his troops in Anglesey and the scene of slaughter which ensued. Indeed, one may go further and say that there is no proof that any Belgic or Brythonic people ever had druids: they belonged to the Celtican Gauls and the Goidelicizing Celts of Britain and Ireland, who had probably accepted the institution from the Pictish race. At any rate, it is significant that the Life of St. Columba introduces the reader to a genuine druid at the court of the Pictish king, near Inverness, where, as well as on Loch Ness, the saint had to contend with him. In any case, it is highly probable that druidism was no less a living institution in Ireland than in the Goidelic and Pictish parts of Britain. Presumably it was more so, and it may be conjectured that Gaulish students of druidism visited Ireland no less than Britain; also, *vice versa*, that Irish druids paid visits to the Celtican part of Gaul where druidism flourished on the Continent, and, in a word, that there was regular intercourse between Gaul and the south of Ireland. If the druids of Ireland, who, among other rôles, played that of schoolmasters and teachers in the country, traveled to Celtica, they must have spread on the Continent some information about their native country, while generations of them cannot have returned to Ireland, with their druidic pupils, without bringing with them some of the arts of civilized life as understood in Gaul; among these one must rank very decidedly the art of writing, which the druids practiced. Now you know the usual account given of the ordinary Latin for Ireland, namely *Hibernia*—to wit, that it was suggested by such native names as that of one of the greatest tribes of that country, namely the *'Ιούερνοι* or *Iverni*, and that it had its *v* ousted when Latin began about the fourth century to write *b* for *v*, and that an *h* was then prefixed to make the word *Hibernia* properly connote the wintry climate which our sister island had always been supposed to enjoy. But now comes the question, where did Pomponius Mela, who flourished about the middle of the first century, get his *Iuverna*, which Juvenal also used? Doubtless from a druid like Dálan, or some other educated native of Ireland, for what the editors print as *Iuverna*, *Iuuerna*, or *Juverna* would appear in ancient manuscripts as *IVVERNA* or *iuuerna*, in which the first two syllables are spelt correctly with *v v* according to a system of spelling well known in Ogmic writing centuries later. But a particular system of spelling seems to me to imply writing, and thus one is encouraged to think that the Ogam alphabet may have been invented no later than the first century in the intercourse I have conjectured to have been going on between the northwest of Gaul and the south of Ireland, where the majority of Ogam inscriptions are now found. But what has archeology to say on the question of such intercourse?

After this digression I come back to the two main streams of Celtic immigration from the same parts of the Continent in two different periods of time. The later of these introduced the *Lingua Brittannica*, which was practically a dialect of old Gaulish; but the affinities of the other Celtic language of these islands, the Goidelic, are not so easy to determine. I have long thought that I can identify traces of it on the Continent, and that its principal home was in the region which Pliny called Celtica, between the Garonne and the Seine. I ventured, accordingly, to call it *Celtican*, as the simpler word *Celtic* had already been wedded to a wider signification. Since then the existence of that language has been placed beyond doubt by the discovery of fragments of a calendar engraved on bronze tablets. This find was made about the end of 1897 at a place called Coligny, in the department of the Ain, and the pieces are now in the museum at Lyons. It is difficult to say for certain whether Coligny is within the territory once occupied by the Sequani, or else by the Ambarri, a people subject to the Ædui, who were rivals of the Sequani and Arverni. The name of the Sequani would seem to have belonged to the Celtican language, and Mr. Nicholson, in his interpretation of the calendar, has ventured in this instance to call it Sequanian. But two inscriptions in what appears to be the same language have come to light also at a place called Rom, in the Deux Sèvres and on the Roman road from Poitiers to Saintes. This Celtican language is to be carefully distinguished from Gaulish, but it is not exactly what I expected it to be: it is better. For several of the phonetic changes characteristic of Goidelic had not taken place in Celtican. Among other things it preserves intact the Aryan consonant *p*, which has since mostly disappeared in Goidelic, as it had even then in Gaulish. This greater conservatism of Celtican enables one to refer to it the national appellation of the people of the region in question, namely that of the *Pictones*, from which it is impossible to sever the name of the Picts of Britain and Ireland, who are found also called *Pictones* and *Pictanei*. Here I may mention that Mr. Nicholson calls attention to instances of tattooing on some of the faces on ancient coins belonging to Poitou and other parts of western France. In the light of the names here in question one sees that *pictos* was a Celtican word of the same etymology, and approximately, doubtless, of the same meaning, as the Latin word *pictus*, that the Celticans had applied it at an early date to the Picts on account of their habit of tattooing themselves, and that the Picts had accepted it (with its derivative *Pictones*) so generally that by the time when the Norsemen arrived in the north of Scotland it was the name which the natives gave them as that by which they called themselves. That is practically proved by the Norsemen calling Caithness and Sutherland *Petta-land*, or the Land of the Picts, and the sea washing its northern shore *Pettalands fiorth*, which survives modified into Pentland Firth.

Another Celtican word of great interest here has by a mere chance come down in a High German manuscript written before the year 814; it is *Chortonicum*, and occurs among a number of geographical names, several of which refer to Gaul, so that Chortonicum may very well have meant the country of the Pictones. At all events, the great German philologist, Pott, at once saw that it was to be explained by reference to the word Cruithne, 'a Pict,' with which it decidedly goes as distinguished from its Brythonic equivalent *Prydyn* (or the older *Priten*) with an initial *p*. The Celtican form originally meant was some such vocable as Qurtonico-n, with the *qu* which was usual in Celtican and early Goidelic, where it formed, in fact, one of the most conspicuous distinctions between those languages and Brythonic or Gaulish, in which *qu* had been changed into *p*.

My remarks have again run into tiresome details, but it is only by attending to such small points that one can hope to force language to yield us any information in the matter of ethnology. It may perhaps help in some measure if I sum up what I have been trying to say, thus:

The first race we have found in possession of the British Isles consisted of a small, swarthy population of mound-dwellers, of an unwarlike disposition, much given to magic and wizardry, and perhaps of Lappish affinities; its attributes have been exaggerated or otherwise distorted in the evolution of the Little People of our fairy tales.

The next race consisted of a taller, blonder people, with blue eyes, who tattooed themselves and fought battles. These tattooed or Pictish people made the Mound Folk their slaves, and in the long-run their language may be supposed to have been modified by habits of speech introduced by those slaves of theirs from their own idiom. The affinities of these Picts may be called Libyan and possibly Iberian.

Next came the Celts in two great waves of immigration, the first of which may have arrived as early as the seventh century before our era, and consisted of the real ancestors of some of our Goidels of the Milesian stock, and the linguistic ancestors of all the peoples who have spoken Goidelic. That language may be defined as Celtican, so modified by the idioms of the population which the earlier Celts found in possession, that its syntax is no longer Aryan.

Then, about the third century B.C., came from Belgica the linguistic ancestors of the peoples who have spoken Brythonic; but in the majority of cases connected with modern Brythonic they are to be regarded as Goidels who adopted Brythonic speech, and in so doing brought into that language their Goidelic idioms, with the result that the syntax of insular Brythonic is no less non-Aryan than that of Goidelic, as may be readily seen by comparing the thoroughly Aryan structure of the few sentences of old Gaulish extant.

Those are the races which have been inferred in the course of these remarks, in which I have proceeded on the principle that each successive band of conquerors has its race, language, and institutions eventually more or less modified by contact with the race, language, and institutions of those whom it has conquered. That looks simple enough when stated so, but the result which we get proves complicate. In any case, I have endeavored in this address to substitute for the rabble of divinities and demons, of fairies and phantoms that disport themselves at large in Celtic legend, a possible series of peoples, to each of which should be ascribed its own proper attributes. But that will only be possible if we can enlist the kindly aid of the muse of archeology.

John Rhys.

CAMPHOR SECRETED BY AN ANIMAL (POLYZONIUM).

In the vicinity of Syracuse, New York, nine or ten years ago a distinct odor of camphor was noticed in connection with a small diplopod, *Polyzonium rosalbum*,* but as this occurred after several hours of miscellaneous collecting in which my hands had been in contact with many plants, as well as with other myriapods and insects, the origin of the scent could not be indubitably established. The observation was subsequently repeated both in Central New York and on Long Island, but there has been no opportunity to follow the matter up until the present season. Learning that *Polyzonium* is abundant in the town of Farmington, Ontario County, New York, I asked my friend Mr. Edgar Brown to send a number of living specimens to me at Washington. These have recently arrived in good condition and have made a satisfactory exhibition of their camphor-producing powers. From a full-grown specimen taken between the thumb and finger no odor is usually perceptible at first, but as the animal struggles to escape, and especially if slight pressure be exerted, the characteristic smell of camphor becomes very distinctly appreciable. If a lens be used at the same time, a milky fluid is seen to exude from the dorsal pores, a pair of which is to be found on each segment behind the fourth. On exposure to the air the liquid very quickly takes on a sticky consistence and may be pulled out into threads half an inch long or more. In addition to the smell there is also the flavor and sharp burning taste of camphor, lasting for a minute or two. The odor is likewise not persistent, gradually decreasing and finally disappearing in a short time.

To eliminate any possibility of error regarding the odor or the material it represents, the animals were submitted to Dr. Oscar Loew who agrees to the diagnosis and informs me that no other substance is recorded as having an odor likely to be mistaken for that of camphor,† and that the existence of camphor as an animal secretion is still quite unknown. This does not, of course, exclude the possibility that a new compound is involved, but, as Dr. Loew admits, a chemical analysis of this animal camphor would require many thousands of the myriapods, while the human nose furnishes, after all, one of the most delicate of chemical tests. For present purposes, then, we must admit camphor as an animal as well as a vegetable substance.

In the economy of the secreting animal, camphor is undoubtedly to be looked upon as a physiological substitute for the prussic or hydrocyanic acid employed in the myriapods of the order Merochæta (*Polydesmus* and its allies) as a means of defense. The liquid is secreted in special glands opening on the surface of the segments at the so-called repugnatorial pores. In these flattened, twenty-segmented forms, as in *Polyzonium*, the repugnatorial secretion seems merely to well up in the pores and spread itself or stand in globules on the surface, whence it evaporates into the air and serves its purpose merely through the strong pungent odor. But in the cylindrical or Iuliform types of Diplopoda, and particularly in the large tropical genera *Spirobolus* and *Spirostreptus*, the repugnatorial apparatus is much more highly developed, so that the animals are able to eject to a distance of several inches a spray of a substance having a very powerful, acrid odor quite different from that of prussic acid. This im-

* *Octoglena bivirgata* Wood is probably a synonym.

† In this connection it may be noted that while camphor has been known hitherto only as a vegetable product it is not confined to a single plant or natural order. The principal commercial supplies come from *Cinnamomum camphora* of the family Lauraceæ, a near relative of the cinnamon, but the Borneo camphor is differently formed by a tree (*Dryobalanops aromatica*) of the family Dipterocarpaceæ, while still another source is said to be *Blumea balsamifera*, a Chinese composite herb. These substances as well as the artificial camphor produced from spirit of turpentine and hydrochloric acid, though not identical in composition nor in physical properties, are closely related by their chemical structure.

pregnates the atmosphere and frequently causes a smarting sensation in the eyes and nose, even when the animals are held at arm's length. At close range the eyes would certainly be most painfully if not seriously affected, and such injury is probably the ground for the fear in which large diplopods are held by the natives of many tropical countries, although the creatures are otherwise quite harmless and may be handled with impunity. In Porto Rico, for instance, it is universally believed that the local *Spirobolus* has a deadly sting in its tail.

When the repugnatorial liquid comes in contact with the skin of the hands a yellowish-green stain results, which gradually deepens to a dull purple. In one instance after collecting a considerable number of large *Spirostrepti* at Conakry, Senegambia, my hands, although washed soon after, became very deeply colored and the skin peeled from the stained areas a few days afterward. As is well known to students of the group, the alcohol in which these large diplopods are collected takes on similar colors, yellowish green at first, changing to a very deep purplish red, and has a characteristic disagreeable odor different from that of the living animal, but still in some respects suggesting it. This odor Dr. Loew considered similar to that of pyridine, though the presence of that substance might possibly be due to a taint of 'denaturalized' German alcohol and would not explain the corrosive action of the fresh fluid upon the cells of the epidermis, which fact denotes a peculiarity of chemical action known in very few organic compounds, and possessed neither by prussic nor by formic acid, now recognized as the poison of the centipedes as of many other animals.

The volatile character of the fluid, or at least of its active constituents, is also as apparent in *Spirostreptus* and *Spirobolus* as in *Polyzonium* and *Polydesmus*. Until disturbed and roused to defensive efforts the creatures are nearly or quite odorless, and some will bear considerable handling before discharging their batteries. Indeed that operation can scarcely be supposed to give pleasure to the animal since its own fumes are soon fatal when it is confined with them in a bottle or small box. The same is also true of *Polydesmus*, *the ability to secrete Prussic acid involving no immunity to that poison* when the creature is obliged to breathe its own gaseous secretion in a closed space. The possibility that a certain amount of resistance to prussic acid may, however, be developed in other animals is suggested by reliable testimony to the effect that one of the monkeys native in Liberia is fond of the locally common species of *Oxydesmus* (*flavomarginatus*, *medius* and *grayi*). There was no opportunity for me to verify this information, but places where the leaves and vegetable debris had been upturned, declaredly by the monkey in searching for his prey, were pointed out to me in the forest, and the flesh of the animal is commonly believed to have the odor of *Oxydesmus* and to be bitter, poisonous and inedible because of this remarkable and unique food habit, on which point the observation and opinion of the natives might be expected to be conclusive, nothing being refused by them which could by any possibility be eaten.

Direct exposure to the light and heat of the sun is also speedily fatal to many Diplopoda. In the case of small and delicate species this might not seem suprising, but the very large and heavily armored *Spiroboli* and *Spirosirepti* are also unable to recover after full illumination for a short time. In ten or fifteen minutes they are often quite dead. That this susceptibility may prove to be the result of some chemical change or dissociation of the stored repugnatorial fluid is apparently indicated by the fact that animals killed by exposure to the sun do not stain the alcohol as described above, the repugnatorial fluid having oozed out and been evaporated from the surface of the segments. This suggests a further possibility that the material elaborated in the repugnatorial glands may not attain its final and effective composition until directly or indirectly acted upon by the air. Camphor would furnish a somewhat different and probably more difficult problem, for though not actively poisonous to us, its fumes seem to have a very detrimental effect upon many of the tracheate Arthropoda. That some of the predaceous insects might be active enemies of such an animal as *Polyzonium* is entirely possible, but it is also to be considered that the small as well as the large Diplopoda may owe to their repugnatorial secretions their comparative immunity from mites and other parasites which commonly attack animals of similar habits. The larger forms are not entirely immune from mites, but when these are found they seem always to be confined to the immediate neighborhood of the head, never occurring on the poriferous segments.

This susceptibility to injury from exposure to sunlight may prove to be an explanation of the hitherto not obvious utility of the eyes of the Diplopoda, which are more sensitive spots, probably quite incapable of effective vision, though possibly of service in seeking shelter. Perhaps some causal relation may also be found in the fact that in the large order Merocheta, where Prussic acid is secreted, eyes are entirely wanting, though absent only in a few subterranean species of other groups. This absence of eyes also renders apparently meaningless the fact recorded by Bruner and Kenyon,* that the repugnatorial secretion of a Nebraska species is luminous. From the sexual standpoint the odor might have a function though the light were merely incidental, but when the nocturnal habits of the animals are considered, phosphorescence may be looked upon as affording a protection additional to that of the odor of the repugnatorial liquid.

In the preceding discussion there has been no intention to imply that the repugnatorial secretion of *Spirobolus* is the same as that of *Spirostreptus*, though there seems to be greater similarity than with *Polydesmus*. Moreover the milky and particularly malodorous liquid excreted by *Spirostrephon lactarium* and probably by other members of the family Lysiopetalidæ is also obviously different from any of the others, so that the elaboration by the class Diplopoda of at least four repugnatorial compounds seems certain, and the idea that Prussic acid is manufactured by all the pore-bearing Diplopoda is shown to be a quite unwarranted generalization.

Two other substances of similar quality and function may be of interest in this connection. One is to be found in the material forcibly ejected by the so-called '*nasuti*' caste or soldiers of termites of the genus *Ptyotermes*. There are several such species in Liberia, the largest, *P. liberiensis*, being deeper brown than the others and having the soldiers of such size that the jets of liquid can by careful observation be seen by the naked eye. The fluid, which is secreted in a special cephalic gland, is clear and watery and does not stain the hands, though alcohol in which the insects are collected becomes dark brown. A smarting sensation in the eyes

* Bruner, *Insect Life*, 1891, III., 319, describes a yellow spot near the lateral edge of each carinæ as luminous. Kenyon, *Publications of the Nebraska Academy of Science*, 1893, 16, doubts whether the luminosity belongs to the repugnatorial secretion because it is described as confined to stationary spots. But in a state of rest it could be expected that only small quantities of the repugnatorial fluid would be continuously given off, and evaporation would take place in the cavity of the pore. Kenyon calls the species *Fontaria luminosa*, but a study of his specimens shows that the generic affinity is rather remote.

and nose is also distinctly appreciable. The odor is even more disagreeably pungent and penetrating than that of *Spirostreptus* and has an almost nauseating quality which pervades the nests and galleries of the species and can readily be detected in houses attacked by this termite. [Isonitriles?] Like the secretion of *Polyzonium* the liquid becomes sticky on exposure to the air, and the insect enemies upon which it is squirted have their antennæ stuck to their bodies and are otherwise disabled.

Another comparable secretion exists in the suborder Geophiloidea of the class Chilopoda which includes the centipedes and their allies, now no longer supposed to have more than the remotest affinity with the Diplopoda. The Geophiloidea are long, slender, carnivorous animals, having from 31 to 173 leg-bearing segments, the number being always uneven. They live in the ground or in the crevices of decaying wood, coming to the surface only at night. In nearly all the species the ventral plate of each segment is perforated by minute pores which are the openings of unicellular glands. In one species, *Orphnæus phosphoreus*, common in the tropics, the secretion which flows from these pores has attracted considerable attention because of its brilliant luminosity, the animal leaving behind it a trail of greenish light. Several other species of different families are known to give off light and that power is probably general in the suborder. Although supposed to be a sexual phenomenon, the purpose of this luminosity, as in the diplopod mentioned above, is scarcely thus explainable, since all the Geophiloidea are, like the Merocheta, quite eyeless. The parallel goes, moreover, a step farther, since the liquid which exudes from the ventral spores of the Geophiloidea* has also an odor closely similar if not identical with that of prussic acid, though like the repugnatorial fluid of *Polyzonium* and *Ptyotermes* it soon assumes an elastic consistence and may be drawn out in threads. Whether this material has anything to do with the webs which the Geophiloidea are said to spin is not known, but the general function is probably repugnatorial and in this the luminous quality might also be of use. The tendency of so many of these secretions to become fibrillar also suggests mention of the fact that in the diplopod suborder Chordeumatoidea, where repugnatorial pores are absent, silk-glands are present, though they can scarcely have any morphological relationship to the pores.

But leaving these unknown substances out of further account, the fact that camphor and prussic acid are quite unrelated chemically is a matter of interest from the evolutionary standpoint. No doubt has ever been expressed that the repugnatorial pores are exact homologues throughout the class Diplopoda, outside of which no morphological equivalents have been recognized. That organs of common origin should produce for the same purposes substances so utterly unlike is a fact that seems very difficult of explanation by existing theories, either from the biological or from the chemical standpoint. For the equipment of pores derived from a common ancestral type and having maintained their repugnatorial function, it would seem necessary to predicate a gradual change of secretion from camphor to prussic acid or from prussic acid to camphor, or from some intermediate substance to these two and to the other unknown derivatives. We have, in fact, a chemico-biological question which can be placed on a genuine phylogenetic basis, the problem being to construct a chain of evil smelling or at least aromatic substances to connect camphor with prussic

* This observation was made and has been verified on two or three occasions with *Geophilus rubens* Say, of which *G. cephalicus* Wood is a synonyn. The species is common in northeastern North America.

acid and pyridine or whatever the unknown quantities may prove to be.

Returning to the camphor-producing animal, it may be noted that *Polyzonium* is a circumpolar genus and is represented in Europe by *P. germanicum*, with which our American form is closely related if not identical. That the nature of the secretion should have remained undiscovered is not suprising in view of the fact that the animal is small (15 by 2 mm.) and of very retiring habits, affecting only the humus of moist, undisturbed forest regions. Moreover it has a very peculiar appearance and would generally be taken for a worm or a small slug rather than for a myriapod, and may not give off its repugnatorial secretion unless injured. Taxonomically it is looked upon as the type of a distinct family, Polyzonidæ, also of a suborder, Polyzonoidea, in which it is, however, associated with a tropical family, Siphonotidæ. With two other suborders also consisting of few genera and few and local species, but having a wide general distribution, the order Colobognatha is made up. This has been found to differ* from other diplopods, not only in the possession of many primitive characters, but in having the copulatory legs not truly homologous, a very reliable indication of long separation in evolutionary history. Of course this is no reason for supposing that *Polyzonium* has preserved the ancestral type of repugnatorial secretion, particularly in view of the fact that camphor is a much more complex substance than prussic acid. That the biological affinity is thus remote, may, however, encourage the chemists by providing all the time necessary for any succession of reactions they may see fit to predicate.

O. F. COOK.

WASHINGTON, D. C.

* "A new Character in the Colobognatha, with drawings of Siphonotus," *American Naturalist*, Oct. 1896, xxx, 839–844.

PROGRESS IN METEOROLOGICAL KITE FLYING.

THE value of the kite in meteorological research is now universally recognized. As a result of improvements in apparatus and methods successively greater heights have been reached until within the past fifteen months, 4300 meters or higher has been reached by Teisserenc de Bort, in France, while at Blue Hill Observatory in this country, 4,850 meters was attained on July 19, 1900. This last height is greater than that of any American balloon ascension where accurate observations were made. Since meteorological kite flying may be said to have begun practically within the past seven years, it is improbable that the limits of maximum height or of efficient work have been reached; for as yet but few individuals or institutions have undertaken such work on an adequate scale.

The work at Blue Hill during the past year indicates that improvement may be expected (1) as a result of further modifying the kite and (2) from experiments to determine the size of wire best adapted for use as line.

The original Hargrave kite with flat lifting surfaces usually attained an angular altitude of 54° to 56° when flown from a short line. The addition of an intermediate lifting surface in the front cell possibly increased this average altitude to 58° or 59° but rendered the kite unstable. In winds of 15 meters per second, or higher, the flat surfaced kites are driven downward by the increase of pressure upon the front edges of the cells, high flights being possible only during favorable conditions. By the addition of rigid curved sustaining surfaces the altitude reached by the best kites is now about 66°, and the average of several kites is about 64°. The effect of wind pressure on the edges of the cells does not seriously affect the altitude until the velocity of the wind exceeds 20 meters per second (true velocity).

When the kite flies at an altitude of 65° its vertical height is about 90 per cent. of the length of the flying line. Greater efficiency is desirable, but at these steep altitudes the kite is not always easily or safely managed when near the ground, especially in variable winds, or when the kite is being reeled in. In the latter case any slight pull upon the line brings the kite beyond the zenith, where it becomes unstable and difficult to handle safely. Refinements in construction may probably remove this defect, but at present it does not seem likely that any great improvement in stability or efficiency may be expected very soon. It is very desirable to know what form of curve for the lifting surfaces is most efficient, also if a lighter, stronger and more easily built frame may be developed.

At present, kites strong enough to withstand winds of 20 to 30 meters per second or higher require a velocity of 5 meters per second or higher to lift them with the meteorograph; and since the larger kites are heavier per unit area than the smaller ones it does not seem desirable to construct kites having an area exceeding 9 square meters. Moreover, such large kites are difficult to handle in high winds.

Steel music wire remains the best material for line, although efforts have been made without success to obtain material of greater tensile strength. At the beginning of the use of wire at Blue Hill, in 1896, it seemed best to use a small wire, since the smaller wires are slightly stronger, weight for weight, than the larger; and with the exception of a short piece of No. 11 wire purchased for trial, No. 14 wire alone was employed until February, 1900, when 7000 meters of No. 17 wire were obtained. Tests of the three sizes of wire showed that when the smallest wire was employed, the limit of safe working strain was reached before the angular altitude of the kites became as high as that reached when the largest wire was employed, although the larger wires were appreciably heavier for the same strength than the smaller. To determine, if possible, the size of wire best adapted for use, the tensile strengths and weights of all sizes of music wire larger than No. 10 were obtained from two leading manufacturers, and are given in the accompanying table. The data from the different sources did not agree exactly and the figures in the table are averages.

DIAMETER, WEIGHT AND TENSILE STRENGTH OF MUSIC WIRE USEFUL AS KITE LINE.

Music Wire Gauge Number.	Diameter (in Millimeters).	Weight of 1000 Meters (in Kilograms).	Tensile Strength (in Kilograms).
10	.61	2.16	85
11	.66	2.60	97
12	.71	3.08	113
13	.76	3.56	126
14	.81	4.00	140
15	.86	4.52	148
16	.91	5.00	162
17	.97	5.71	178
18	1.02	6.37	189
19	1.07	6.94	203
20	1.12	7 46	223
21	1.17	8.33	236
22	1.22	9.09	256
23	1.29	10.00	281
24	1.40	11.48	311
25	1.50	13.51	350
26	1.60	15.63	402
27	1.70	17.54	450
28	1.80	20.00	533
29	1.88	22.22	590
30	1.98	24.39	657

A careful examination of all the data shows that the cause of the greater efficiency of the larger wires is that they present relatively less surface to the wind than do the smaller; and that, instead of being an insignificant effect, as some have supposed, the pressure of the wind upon the wire is a most important one. The surface of a No. 17 wire presented to the wind is nearly one square meter for each thousand meters of length; and since, in very high flights 8,000 to 12,000 meters of wire are in the air, the total pressure of the wind must be very great and its tendency is always to drive the wire and kites to a lower altitude. Wind pressures of 30 to 50 kilograms per square meter of surface exposed normally to the wind are not uncommon, and it appears that the line presenting the smallest surface, relative to weight, is the one best to employ. Considering the wire alone, there is an advantage in using the largest size of wire, but there appears to be a practical limit to the number of kites that may be efficiently employed on one line. At Blue Hill, at present, the average number of kites employed at one time is six—three large and three small—having a total lifting surface of less than 30 square meters. Since it is not desirable to increase the size of the kites, the increased power required to lift a larger wire must be derived from a number of the largest kites now used ; and since more than eight kites can seldom be used to advantage, it appears that a No. 25 or a No. 26 wire will give the best results, until there can be obtained better kites capable of lifting a larger wire. It is also probable that a line made up of several different sizes of wire may be more efficient than one of uniform size.

The present maximum height (4,850 meters) in all probability is not the highest attainable with No. 17 wire, and while it is unsafe to predict the result of future experiment, it now seems likely that, with a stronger line and kites of greatest efficiency, heights exceeding 6,000 meters are within reach. Moreover, flights to elevations of 4,000 meters or higher could be made more quickly and easily than at present.

S. P. FERGUSSON.

BLUE HILL OBSERVATORY,
September 12, 1900.

SCIENTIFIC BOOKS.

THE PUBLICATIONS OF THE VOLTA BUREAU.

WHILE the Volta Bureau was founded, by Alexander Graham Bell, 'for the increase and diffusion of knowledge relating to the deaf,' with a philanthropic desire to promote their welfare, the publications of the bureau will interest students in many departments of science, and the purpose of this review is to call attention to some of the general bearings of two of these publications.

I. *The Helen Keller Souvenir* (2) Commemorating the Harvard Final Examination for Radcliffe College, June, 1899. By A. GRAHAM BELL, ANNIE M. SULLIVAN, and others.

It is less remarkable that Helen Keller, who was born blind as well as deaf, has passed the examinations for admission to Harvard University, '*with credit in advanced Latin*': than that she has become so familiar with the use of language that she finds no more difficulty in the work of the college class-room than any other bright student.

The way in which this result has been reached, in the face of such difficulties, should be studied by all teachers, not only for their encouragement, but because they will find in it an illustration of the requisites which are essential for all successful instruction.

Her first teacher, Miss Sullivan, speaking of her at the age of twelve, or thereabouts, says that while her accomplishments seem marvelous to many, they "consist *only* in her being able to speak and write the language of her country with greater ease and fluency than the average seeing and hearing child of her age." Miss Sullivan asks whether we may not hope for similar results with children who are so fortunate as to have eyes and ears with which to see and hear, and all who are familiar with the lamentable failure of a common school education to give command of the English language must feel an interest in the answer.

Helen Keller was not *taught* the use of language. She was put into the way to discover its meaning, and was left to make the discovery for herself, as every normal child does, and as we find out everything else that is worth knowing. But while normal children make this discovery at too early an age to be able to tell us about it, Helen did not make it until she had enough maturity of mind to reflect upon it, and enough natural knowledge to know her need of it, and to understand its value.

All students of psychology will be interested in her account of the discovery that things have names and that one name may stand for several things of a kind. She had been taken to the pump-house to feel the water as it gushed from the pump, and as she was enjoying the pleasant sensation, I (Miss Sullivan) spelled the word *water* in her hand, and instantly the secret of language was revealed to her. Helen says: "That word, meaning water, startled my soul, and it awoke full of the spirit of the morning, full of joyous, exultant song. Until that day my mind had been like a darkened chamber, waiting for words to enter, and light the lamp, which is thought."

The guiding principle of her early education was this aphoristic precept by Professor Bell: "I would have a deaf child read books in order to learn the language, instead of learning the language in order to read books." It is by imitation that language is acquired, and it may be that it was Helen's good fortune that she was not able to copy from the feeble and ill-considered efforts to talk English, which make up ordinary conversation.

"The great principle that Miss Sullivan seems to have had in mind," says Professor Bell, "in the instruction of Helen, is one that appears obvious enough when it is once formulated, and one with which we are all familiar as the principle involved in the acquisition of language by ordinary hearing and speaking children. I talked to her almost incessantly in her waking hours"; says Miss Sullivan, "spelled into her hand a description of what was transpiring around us, what I saw, was doing, what others were doing—anything, everything. Of course, in doing this, I used multitudes of words she did not understand at the time, and the exact definition of which I did not stop to explain. I gave her books printed in raised letters long before she could read them, and she would amuse herself for hours each day in carefully passing her fingers over the words searching for such as she knew, and she would scream with delight whenever she found one. Helen's remarkable command of language is due to the fact that books printed in raised letters were placed in her hands as soon as she knew the formation of the letters. It is not necessary that a child should understand every word in a book before he can read it with pleasure and profit. Helen drank in language which she at first could not understand, and it remained in her mind until needed, when it fitted itself naturally and easily into her conversation and compositions. Thus she drew her vocabulary from the best sources, standard literature, and when the occasion came she was able to use it without effort. She has had the best and purest models presented to her, and her conversation and her writings are unconscious reproductions of what she has read."

So well had Miss Sullivan done her work that the instructor who prepared Helen for college says: "I read Shakespeare with her, and she showed the greatest pleasure in the light and amusing touches in 'As You Like It,' as well as in the serious passages of 'King Henry V.' We took up Burke's celebrated speech on Conciliation with the Colonies, and every point made an impression. The political bearing of the arguments, the justice or injustice of this or that, the history of the times, the characters of the actors, the meaning of the words and the peculiarities of style, all came under review, whether I wished it or not, by the force of Helen's interest." In the list of words which she understood without explanation are policy, impunity, immunity, dragooning, illation, inquisition, acquiesces, mediately, congruity, etc.

II. *Marriages of the Deaf in America;* an Inquiry concerning the Results of Marriages of the Deaf in America. By Edward Allen Fay.

Few books on the inheritance of human faculties are more important than this volume which Professor Fay has prepared as the result of researches which have been carried on under the auspices and through the aid of the Volta Bureau. It is by far the most conclusive proof which has ever been obtained that there is no inheritance of acquired characters, so far at least as the inheritance of deafness is in question, for while Professsr Fay proves that the marriage of deaf persons without deaf relatives is no more likely to result in deaf children than any marriage in the community at large, the intermarriage of hearing persons who have deaf relatives is just as likely to result in deaf children as a marriage of the deaf.

The report will be welcomed by all students of inheritance from the scientific standpoint; although it was undertaken and has been carried on, we are told, "in the hope that it might be of service to the deaf, and to society by settling definitely the question whether or not the deaf are more liable than hearing persons to have deaf children; and if it should appear that, notwithstanding the numerous instances to the contrary, they are more liable to this result, by ascertaining whether or not the liability is increased by the marriage of the deaf with one another; also whether certain classes of the deaf, however married, are more liable than others to have deaf children; and, if this should prove to be the case, by determining how these classes are respectively composed, so that as a result of the conclusions reached, in many instances deaf persons might be advised to follow the choice of their own hearts in marriage, with no restrictions whatever, except such as should influence all right-minded persons in this important matter; while in cases where the deafness of the parent was unquestionably more liable than in others to reappear in the offspring, the persons interested might be effectively warned in time of the danger incurred."

The tables of facts regarding the deaf which make up most of the report are accompanied by a thorough and exhaustive analysis, which shows that this practical philanthropic purpose has been accomplished, and that Professor Fay is now able to give to those deaf persons who contemplate marriage advice which has the value of scientific demonstration.

Professor Bell has shown that marriages of the deaf are more common in America than in Europe, that they have increased at a higher rate of progression during the present century, that the probability of deaf children is much greater among the deaf than in the community at large, and that deafness—not mere hardness of hearing, but what is called 'deaf dumbness'—is also increasing among us, and that we are threatened with a deaf variety of the human race. At the same time, it is clear that the probability of deaf children is not equally great among all deaf persons who marry and have children. A person who has lost hearing by accident or disease, at however early an age, may possibly be in no more danger of transmitting the peculiarity than one who has lost an eye or an arm. It is therefore highly important, in the interest of the deaf as well as in the interest of the community, to determine the conditions which are favorable and those which are unfavorable to the hereditary transmission of deafness.

This report contains more than three hundred and fifty pages of statistical information, giving, for some 8,000 deaf persons who have married, data regarding the origin of their deafness, the hearing or deafness of the partner in marriage, the date of marriage, the number of children, the number of deaf children, a record as to the hearing or deafness of brothers and sisters, and information as to the existence of other deaf relatives. These tables, which contain a record of the marriages of the deaf far larger than all previous records put together, are of great interest to all students of inheritance, but their motive is philanthropic rather than scientific.

While deaf persons are much more likely to have hearing children than to have deaf children, they are much more likely than ordinary normal-hearing persons to have deaf children. Less than one-tenth of one per cent. of all the children of normal parents are deaf, but if one or both parents are deaf, nearly nine per cent. of all the children are deaf. In other words, a normal-hearing pair have no reason to fear that a deaf child will be born to them unless they have more than a thousand children; while if one parent or both are deaf, and they have eleven children, they may, on the average, expect to have one deaf child.

The probability of deaf children is not, however, equally great for all deaf persons, since it depends upon the character of the parental deafness. Marriages of the congenitally deaf, that is, of persons who have never, at any time in their lives, shown evidence of hearing, are far more likely to result in deaf offspring than marriages of the adventitiously deaf, that is, of those who have once heard and have subsequently lost their hearing. Of 526 marriages between a congenitally deaf person and a congenitally deaf or a hearing partner, 111, or 21 per cent. resulted in deaf offspring; and 20 per cent. of the children, or one in each five, were deaf; while of 1,155 marriages where one partner was adventitiously deaf and the other adventitiously deaf or hearing, only 40, or 3½ per cent., resulted in deaf offspring; and only 2 per cent. of the children, or one in each fifty, were deaf.

If it were possible to draw this line with rigorous accuracy, and to divide all the deaf into these two classes, all deaf persons with a marked probability of deaf children would be found in the first class, while the members of the second class, the adventitiously deaf, would have little reason to fear the transmission of their deafness to posterity; but, as a practical matter, it is not possible to draw this line with scientific exactness. Deafness is not usually discovered until the child has reached the age when children usually begin to talk; and it is difficult to determine whether the hearing has been destroyed during this period or has been deficient from the first. If the child has suffered from some disease which is known to frequently result in deafness, the case is regarded as adventitious, although it may possibly be congenital. If, on the other hand, no such disease has been observed, the case is likely to be regarded as congenital; but it is, perhaps, just as likely that hearing has been lost in consequence of some unnoticed inflammation of some part of the auditory apparatus, occurring at some time before the deafness was discovered. In fact, one who, having heard, afterwards becomes deaf as the effect of disease, may be an example of congenital deafness. When deafness is said to be inherited, it is not actual deafness, but some constitutional weakness or susceptibility to disease that is transmitted, and a child who has heard and has afterwards lost its hearing may, while regarded as a case of adventitious deafness, have the same significance in inheritance as one born deaf.

The term 'congenitally deaf' usually means 'supposed to be congenitally deaf,' and 'adventitiously deaf' often means 'supposed to be adventitiously deaf.' Some more accurate method of classifying the deaf must be employed before we can clearly express the probability of deaf children in any given marriage of the deaf.

It is well known that deafness often prevails in families; that deaf persons often have deaf relatives; and the arrangement of the deaf-married persons, according to the existence or non-existence of deaf relatives gives results which are most instructive.

In 437 marriages of deaf persons where both partners in marriage had deaf relatives, more than 25 per cent., or one in four, resulted in deaf offspring; and more than 20 per cent., or one child in each five, were deaf. In 471 marriages where neither partner had deaf relatives, only 2½ per cent. resulted in deaf children, and only one child in each hundred was born deaf (1¼ per cent.). When we consider how few persons especially in America, where changes of residence are frequent, are acquainted with the condition of all their relatives, it is not improbable that there were unknown or unreported deaf relatives in some of these marriages and that marriages of this class are even less likely to result in deaf offspring than the tables indicate.

Indeed, Professor Fay is led to the conclusion that even when deafness is congenital, it should not be regarded as a bar to marriage if neither of the partners in marriage has deaf relatives since the tendency to transmit deafness if it exists at all, is very slight. On the other hand, the marriage of a deaf person to a hearing person with deaf relatives is much more hazardous than the intermarriage of deaf persons without deaf relatives. In fact, careful study of the tables indicates that the marriage of two hearing persons who have deaf relatives is just as likely to result in deaf offspring as the intermarriage of two deaf persons who have deaf relatives. Taking all the marriages of a year's standing or longer of which the results have been reported, where both the parents had deaf relatives, more than 25 per cent. of the marriages resulted in deaf offspring, and the proportion of deaf children born to them is 20.9 per cent.; where one of the parents has deaf relatives while the other has not, the proportion of marriages resulting in deaf offspring is 6.6 per cent.; where neither of them had deaf relatives only 2.3 per cent. of the marriages resulted in deaf offspring; and the proportion of deaf children born therefrom is 1.2 per cent. The actual percentage of marriages resulting in deaf offspring, and the number of deaf children born therefrom, when neither of the parents has deaf relatives, may be even smaller than these figures indicate; for in some cases the statement that neither parent had deaf relatives is not well authenticated, and in all of them there is the possibility that there may have been deaf relatives who were unknown to the person who filled out the record-blanks. Professor Fay is led to believe, from the study of the records, that the probability of deaf children, where neither parent had deaf relatives, is very slight, perhaps no greater than in ordinary marriages.

The marriages of the deaf most liable to result in deaf offspring are those in which the partners are related by consanguinity. Thirty-one such marriages are reported in the marriage records, and of these 14, or 45.1 per cent., resulted in deaf offspring. One hundred children were born from these thirty-one marriages, and of these 30, or 30 per cent., were deaf. It is, therefore, exceedingly dangerous for a deaf person to marry a blood relative, no matter what the character or degree of the relationship may be, and no matter whether the relative is deaf or hearing, nor whether the deafness of either or both or neither of the parents is congenital, nor whether either or both or neither of them have other deaf relatives.

The student of inheritance will, no doubt, be disposed to state this conclusion in more general terms, and to assert that the consanguineous marriage of one who has *any* constitutional infirmity or defect is imprudent and inadmissible, and that since no one can be sure that both parties to a contemplated marriage are constitutionally sound in all respects, no consanguineous marriage is permissible.

The writer of this review prepared, by request, some twelve years ago, an essay on the conditions which are necessary for the production of a deaf variety of the human race, which was printed in the Report of the Royal Commission on the Blind, the Deaf and Dumb, etc. London, 1889.

In this essay he gave reasons for holding the only necessary condition to be that successive generations of persons—either deaf or hearing—*with deaf relatives* should marry and have children.

This opinion was so much opposed to the views on inheritance which were current at that day that none of the eminent men of science—seven in number—who prepared essays upon the same subject, gave it any support, or even took it into consideration. Most of them, indeed, held that a deaf variety of the human race may be expected to result from the intermarriage of successive generations of deaf persons.

Professor Fay's thoughtful and exhaustive analysis of the da taafforded by the records of some 4,500 records of marriages of the deaf shows that the view of the matter which was reached by the writer twelve years ago, on theoretical grounds, turns out to be a fact so soon as it is submitted to a practical test.

W. K. BROOKS.

Exploitation technique des forêts. Exploitation commerciale des forêts. Two Volumes. By M. H. VANUTBERGHE, Ingénieur agronome Garde général des Forêts. 8vo. Paris, Gauthier-Villars.

With the establishment of professional schools of forestry at Cornell and Yale Universities and the promise of others to follow, technical forestry literature will naturally receive more attention in this country than hitherto. Foreign literature, however, except the few standard text-books and the best journals, will hardly attract much attention, unless it is essentially new in matter or manner. The two volumes under review bring nothing new in matter to the professional man, but some portions are treated in an unorthodox, independent manner which will appeal to the thinking student and practitioner, even though he may not agree always with the author's views. To find these volumes published as a part of an *Encyclopédie scientifique des aide-memoire* is rather surprising, for they are by no means, as one would expect, reference books or brief reviews, but in large part rather argumentative and free in style, attempting to impress the author's radical views unbiased by the orthodox tenets upon the reader, while the other parts are without interest to those to whom the argument might appeal. It is difficult to imagine what class of readers the author intended to serve. Like most books written from the Continental point of view—*i. e.*, starting out with established conditions of forestry practice—much is unpalatable and of little import to the American reader. The title, division and treatment of the subject also are novel with the author, and not always fortunate. The term 'exploitation' does not, as in English, mean the mere rough utilization, but the very opposite, a regulated management. Under *exploitation technique* he discusses not only the methods of regulating the management of a forest for continuous revenue, but also silvi-cultural operations—*i. e.*, the methods of securing the wood-crop—while under *exploitation commerciale* the methods of harvesting the crop are discussed, and the commercial considerations that enter into it either with or without reference to the future conditions of the property. From this little is to be learned for our practice. Yet it is interesting to note that evidently good forestry practice is not as general among private forest-owners in France as is usually supposed, for the author declares silvi-culture 'a new art,' primitive in its development, deficient in scientific basis and 'official'—*i. e.*, practiced mainly by the government officials in government forests. We agree with the author that forestry as a business commends itself mainly to rich people, to eternal persons like the state, and not to people who have the natural desire to increase their property by their labor. Forestry is, as the Germans term it, *kapital-intensiv*, and *arbeits-extensiv*—business, *i. e.*, relying to a large extent on capital, with small chance of increasing the earnings by intensive application of labor. Especially for timber purposes it requires large areas in one hand, a persistent system of management and a 'wholesale' organization. Small space and little light are given on the difficult and complex question of rotation (*principe de l'exploitabilité ou eqoque de la récolte*)—*i. e.*, the length of time to which it is desirable to allow the crop to grow—when to cut the crop. This problem is *sui generis* in forestry, unknown to other industries, and as the author very wisely points out, requires a different solution according to whether the state, with its long existence and providential functions, or a private owner is concerned. Since to a certain point 'the value of a tree grows at least as the cube of the diameter,' from the standpoint of the financier the harvest time would have arrived when this value is at a maximum, if other calculations, namely, interest on investment, cost of production, etc., to be charged with compound interest, did not vitiate this simple device. The author concludes that 'every harvest of old timber is economically or financially a bad operation' which contemplation leads to short rotations, hence the production of heavy timber is not for private enterprise, which thesis the author supports by examples. Most space is given to the consideration of the 'felling budget' (*offre raisonné*) in a sustained-yield management which the author calls with a new term '*possibilité en fertilité*'—*i. e.*, a management which only reaps the amount annually accumulating (*revenue*) if the soil is properly stocked with a wood capital (*valeur génératrice*).

We learn here to distinguish financially between two distinct values, which may attach to one and the same forest property, namely, the realizable (sale) value (*valeur de réalization*) based upon what can be realized at once by a crude exploitation of the standing timber, and the investment value (*valeur de placement*) based upon what can be continuously realized from the property by a forest management, a distinction which will only gradually vanish, the author expects, when the old natural woods have vanished or the State has hold of them. The same expectations are in place in the United States, notwithstanding the sanguine assertions of enthusiasts.

B. E. Fernow.

Technic of Mechanical Drafting. By C. W. Reinhardt. (Pub. by Engineering News Co.)

Mechanical draftsmen and teachers of graphics may well add to their working libraries this volume, in which the chief draftsman of the *Engineering News* gives to the profession the 'wrinkles,' 'short cuts' and methods in general which have approved themselves to him during his long experience. As the author frankly admits, this is not a complete work for beginners, as all theory of construction is omitted; but as an adjunct to existing text-books it must prove of great service, being especially rich in examples of conventional representation and of line shading. Incidentally it shows also the remarkable adaptability of the author's system of lettering to reduction by photo-processes.

F. N. WILLSON.

PRINCETON UNIVERSITY.

BOOKS RECEIVED.

Elements of Mineralogy, Crystallography and Blowpipe Analysis. ALFRED J. MOSES and C. L. PARSONS. New York, D. Van Nostrand Company. 1900. Pp. vii + 409.

Elements of Physics for Use in High Schools. HENRY CREW. New York, The Macmillan Company. 1900. Second Edition Revised. Pp. xvi + 353. $1.10.

Ethnology. MICHAEL HABERLANDT. Translated by J. H. LOEW, London, Dent. Pp. viii + 169.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Physiology* for October contains a very interesting and suggestive article by D. J. Lingle on 'The Action of certain Ions on Ventricular Muscle.' Particular attention is paid to the rhythmic activity of heart tissue as an ion effect. Strips from the ventricle of the turtle's heart were placed in solutions of non-conductors, in solutions of sodium, of calcium, and of potassium, and in solutions of these salts combined. Lingle found that the non-conductors he used (cane sugar, dextrose, glycerine) did not occasion rhythmic beats in the heart strips. In the solution of sodium salts, however, the strips always beat rhythmically. If a strip is kept in the solution the beats reach a maximum and then gradually decline to a complete standstill. The stopping is apparently due to poisonous action of the sodium salt alone, for the rhythm is prolonged by diluting the solution in which the strip remains or by exposing the strip for a shorter interval to the action of the strong solution. When transferred to solutions of sodium salts, strips which have been quiescent in non-conductors begin to beat as suddenly as if started by an electric shock. The application of calcium salts and the treatment of the tissue so that an excess of calcium salts remains in the tissue both fail to start rhythmic beats. Potassium salts are likewise ineffective. Moreover calcium and potassium in combination do not start beats, while sodium chloride always succeeds. These results have a remarkable similarity to the results obtained by Loeb on rhythmic contractions in striped muscle and the tissue of the swimming bell. According to Lingle, sodium and not calcium is the stimulus for rhythmic contraction in the heart; calcium and possibly potassium salts improve the rhythm by neutralizing the injurious action of pure sodium salt solutions. W. T. Porter and H. G. Beyer in a paper on 'The Relation of the Depressor Nerve to the Vasomotor Center' raise the question, Does the bulbar vasomotor center act as a physiological unit to lower or raise the general blood-pressure, or has it parts regulating the regional distribution of blood? This question they have endeavored to answer by investigating the depressor nerve, an afferent nerve regarded by Cyon and Ludwig as stimulating the bulbar vasomotor center to cause especial dilatation of abdominal blood vessels. First the depressor nerve was stimulated when the splanchnic nerves were prepared for experimentation but still intact. This caused a fall in blood-pressure usually from 35 to 40 per cent. Next the abdominal vessels were removed from vasomotor influence by cutting the splanchnic nerves. The blood-pressure which falls on cutting these nerves was restored to the normal level either by stimulating the peripheral ends of the cut nerves, or by intravenous injection of normal salt solution. Now, with the abdominal vessels free from vasomotor influence and the blood-pressure normal, the depressor nerves were again stimulated. The blood-pressure fell usually as much as it had previously fallen when the abdominal vessels were still connected with the bulb. From their results the investigators conclude that the depressor nerve has no special connection with cells controlling vasomotor fibers of the splanchnic nerves, and they express the opinion that afferent nerves affect all the bulbar vasomotor cells alike. The bulbar vasomotor center, therefore, would not regulate the distribution of the blood in the several regions of the body, but would merely raise or lower the general blood-pressure.

The American Naturalist for August opens with an article 'On the Nesting Habits of the Brook Lamprey (*Lampetra wilderi*),' by Robert T. Young and Leon J. Cole, followed by a paper 'On Variation of the Rostrum in *Palæmonetes vulgaris* Herbst,' by Georg Duncker, in which the writer takes the ground that there is no relation between the average and the variability of a character. Frank Smith gives 'Some additional Data on the Position of the Sacrum in Necturus,' concluding that we need more data before trustworthy conclusions can be reached, and J. R. Slonaker describes 'A Strange Abnormality in the Circulatory System of the Common Rabbit (*Lepus sylvaticus*),' consisting of a connection between the portal vein and posterior *vena cava*. 'The Origin of the Middle Ocellus of the Adult Insect' is considered by Chujiro Kochi, and this is followed by part XII. of the 'Synopses of North-American Invertebrates' devoted to 'The Trematodes, Part I., The Heterocotylea or Monogenetic Forms,' by H. S. Pratt. There are numerous interesting reviews.

The Plant World for August has for its first article 'When Increase in Thickness begins in our Trees,' by Geo. T. Hastings, giving the results of some recent experiments. 'Judging by the Fruits,' by Byron D. Halsted, presents two series of examination papers with their answers based on a change of text-books from 'Gray's Lessons' to 'Coulter's Plant Relations.' C. F. Saunders describes the 'Root System of the Snake-Mouth Pagonia,' and the same writer gives a view of 'Quaker Bridge, New Jersey,' the spot where the very rare fern, *Schizæa pusilla*, was discovered. The Supplement, devoted to the 'Families of Flowering Plants,' by Charles Louis Pollard, contains descriptions of the Smilaceæ, Hæmodraceæ and several succeeding families.

In *The Osprey* for August Paul Bartsch continues 'Birds of the Road,' and Theodore Gill gives the sixth part of 'William Swainson and his Times,' coming down to the acquaintance of Swainson and Audubon and the interesting correspondence between the two. In the 'Letters' Witmer Stone prints a communication from Cassin on Baird's first paper, in which he described *Empidonax flaviventris* and *E. minimus*.

The Popular Science Monthly for September commences with an interesting account of 'The Modern Occult,' by Joseph Jastrow, concluding that it is Utopian to look forward to the day when the occult shall have disappeared. Frederic A. Lucas discusses 'Birds as Flying Machines,' drawing attention to the fact that there are various modes of flight. Wm. Baxter, Jr., describes 'Electric Automobiles,' and E. B. Rosa considers 'The Human Body as an Engine,' finding a striking parallel between the body and a locomotive. Simon Newcomb continues 'Chapters on the Stars,' treating mainly of their spectra and spectral research, and Havelock Ellis gives the second part of 'The Psychology of Red.' 'The Expenditure of the Working Classes' is treated by Henry Higgs, who considers that they waste a great deal, and George G. Groff presents a somewhat optimistic view of the 'Conquest of the Tropics.' In the Correspondence, R. E. C. Stearns shows the 'Antiquity of the Chewing Gum Habit' and there are some good summaries in 'The Progress of Science.'

NOTES ON INORGANIC CHEMISTRY.

When a decade or so ago the problem was solved of obtaining aluminum at a comparatively low cost, it was believed by many that there would be at once an immense demand for the metal, and that it would replace iron and perhaps other metals for many purposes. While this has not been the case, the demand for aluminum and the corresponding output have steadily, if slowly, increased, and at the present time are increasing rapidly. In the *Zeitschrift für angewandte Chemie*, W. C. Heraeus calls attention to the increasing use of aluminum in the chemical industries. One great difficulty heretofore in using aluminum for such purposes has been that when in contact with another metal, galvanic currents are generated which rapidly corrode the aluminum. It has hence been impossible to use vessels where the metal was soldered. A process has recently been devised which enables the welding of aluminum without the aid of a flux. This will greatly increase the usefulness of aluminum. The tensile strength of the metal is only one-fourth less than that of copper, and while its conductivity for heat is only half as great as that of copper, it is twice as great as that of iron. The use of aluminum as a conductor of electricity is also growing rapidly.

AN interesting investigation has recently been carried out by H. J. Möller of Copenhagen, and published in the *Berichte* of the German Pharmaceutical Society, on colored glasses, with particular reference to the proper color for bottles which are intended to protect medicines, etc., from the chemical action of the light. It was found that the best protection is afforded by black (opaque), red, orange and dark yellowish-brown glass—light brownish-yellow, dark green (with no bluish tint) and dark brownish-green glasses afford quite good protection; bluish-green, violet, milky, bluish and colorless glasses give little if any protection from the actinic rays of sunlight. For the preservation of wine, beer and liquors, dark brownish-yellow and dark yellowish-brown bottles are to be preferred, while light brown, light green and bluish-green glass is less to be recommended.

A NEW and curious chapter has been added to the chemistry of the radio-active elements by A. Debierne in one of the latest *Comptes Rendus*. By dissolving barium chlorid in a solution of actinium and then crystallizing or precipitating it out, a radio-active barium is obtained which shows many similarities to the radiferous barium from pitch blende. Its rays are capable of ionizing gases, excite the phosphorescence of barium cyanoplatinite, are photographically active, and are partially deflected in a magnetic field. The anhydrous chlorid thus obtained is self-luminous. On the other hand, this salt shows only the spectrum of pure barium, while that from pitch blende gives the radium spectrum. The former gradually decreases in activity, while the latter increases up to a maximum, at which it remains constant. Debierne considers that it is improbable that his active barium should contain any radium or any actinium, but that it is probable that by prolonged contact with actinium salts the barium has become itself temporarily active. This inductively active barium appears to be intermediate in its properties between radium and barium.

J. L. H.

EXPERIMENTAL STATIONS IN HAWAII AND PORTO RICO.*

THE last appropriation acts for the Department of Agriculture carried provisions for the inauguration of experiment stations in the islands of Hawaii and Porto Rico. In accordance with this the preliminary steps have been taken to determine the best plan of operation in each case and the subjects which are in most need of immediate attention.

Professor S. A. Knapp, of Louisiana, who for a considerable number of years has been engaged in subtropical agriculture on an extensive scale, was selected to investigate the agricultural conditions and possibilities of Porto Rico. Professor Knapp went to the island early in June. In general he will study the present agricultural conditions existing in Porto Rico, the lines of experimental investigation which should be undertaken there, especially in the immediate future, and the locations suitable for stations, together with the approximate expense of inaugurating and maintaining the work of the stations. He will also look into the feasibility of undertaking cooperative experiments with the residents of Porto Rico, and the best means of reaching the people through different classes of publications, demonstration experiments, and otherwise.

For the preliminary survey of the conditions in the Hawaiian Islands, Dr. W. C. Stubbs, director of the Louisiana Experiment Station, has been selected as especially fitted by experience. Dr. Stubbs sailed for Hawaii about the middle of July, and will spend the month of August in the islands. The conditions there with reference to station work are different

* From the *Experiment Station Record*.

from those in Porto Rico, as a station for experiments in sugar production has been maintained by private beneficence for a number of years. In connection with his investigation of the location of a station, Dr. Stubbs will consider the feasibility of combining the Federal station with the Hawaiian Experiment Station or the agricultural department of the Kamehameha Manual Training School at Honolulu. Here also the lines in which investigation is most needed, the possibility of greater diversification of the agriculture, the expense of inaugurating and maintaining experiment station work, and the means of disseminating information among the people will be carefully inquired into. This will probably prove a profitable field for investigations on the use and economy of water in irrigation, since according to reports received from authentic sources, in no other place is so much money expended for pumping water for irrigation. Some of the pumps are said to be raising 30,000,000 gallons of water per day from a depth of 500 feet, using coal that costs $10 a ton. The expense of irrigating in some cases reaches as high as $125 per acre annually.

SCIENTIFIC NOTES AND NEWS.

The attendance at the Bradford meeting of the British Association was 1,915 distributed as follows: Old life members, 267; new life members, 13; old annual members, 297; new annual members, 45; associates, 801; ladies, 483; foreign members, 9. The British Association is fortunate in always arousing local interest and securing a large number of associates. It will be noted, however, that the attendance of members at Bradford—622—was not greatly in excess of the attendance at meetings of the American Association, although American men of science are scattered over a much wider area and undergo greater inconvenience in coming together in mid-summer.

The grants appropriated for scientific purposes amounted to £945 and were distributed as follows: Mathematics and Physics—electrical standards (balance in hand), and £45; seismological observations, £75; magnetic force on board ship, £10. Chemistry—relation between absorption spectra and constitution of organic substances (balance, £6 8s. 9d. in hand); wave length tables, £5; isomorphous sulphonic derivatives of benzene, $35. Geology—erratic blocks (£6 in hand); photographs of geological interest (balance, £10 in hand); ossiferous caves at Uphill (renewed), £5; underground water of Northwest Yorkshire, £50; exploration of Irish caves (renewed), £15; life-zones in British carboniferous rocks, £20. Zoology—table at the Zoological Station, Naples, £100; table at the Biological Laboratory, Plymouth, £20; index generum et specierum animalium, £75; migration of birds, £10. Geography—terrestrial surface waves, £5; changes of land-level in the Phlegræan fields, £50. Economic Science and Statistics—state monopolies in other countries (£13 13s. 6d. in hand); legislation regulating women's labor, £15. Mechanical Science—small screw gauge (balance in hand) and £45; resistance of road vehicles to traction, £75. Anthropology—Silchester excavation, £10; ethnological survey of Canada, £30; age of stone circles (balance in hand); photographs of anthropological interest (balance of £10 in hand); anthropological teaching, £5; exploration in Crete, £145. Physiology—physiological effects of peptone, £30; chemistry of bone marrow, £15; suprarenal capsules in the rabbit, £5. Botany—fertilization in phæophyceæ, £15; morphology, ecology and taxonomy of podostemaceæ, £20. Corresponding societies—preparation of report, £15.

One of the most important actions taken at Bradford was a reference to the Council with a favorable recommendation of a plan for the establishment of a section of education which should deal not only with scientific education, but with education as a science. The report of the treasurer showed receipts of over $11,-000, but the expenses of the year exceeded the receipts by about $4,000. This deficit was due to the fact that the Dover meeting last year was rather small, while the grants were as large as usual and there were some extra expenses in connection with the visit of the French Association. The items of expenditure were in round numbers $5,000 for printing, $2,500 for salaries, $2,000 for the expenses of the Dover meeting and $5,000 for scientific grants. In receipts and in the amount annually granted for scientific research the American compares unfavorably with the British Association. The difference is explained by the large number of local associates. If the 'ladies' noted above are all associates the local contribution to the funds of the Association at Bradford amounted to over $6,000.

Dr. W J McGee, ethnologist in charge of the Bureau of American Ethnology, has undertaken an expedition to southwestern Arizona and Sonora, for the purpose of continuing researches among the Papago Indians and extending the studies to the practically unknown Tepoka tribe, supposed to inhabit the eastern shore of the Gulf of California, midway between the mouth of Colorado river and Tiburon island. Not a word of the Tepoka language has ever been recorded, and not a single specimen of their handicraft is in any museum.

MM. Chauveau and Cornu have been designated by the Paris Academy of Sciences as delegates to the International Commission on Physiological Instruments, of which M. Marey is the president.

M. Yersin, to whom the Paris Academy of Moral Sciences recently awarded a prize of 15,000f. for philanthropic acts, has devoted the sum to his anti-plague serum establishment at Nha-trang.

Sir Michael Foster has returned to England after having given a series of lectures before the Cooper Medical College, San Francisco. He was unable to be at Bradford as retiring president of the British Association.

Dr. W. L. Bryan, professor of philosophy in the University of Indiana and vice-president, attended the recent International Congress of Psychology at Paris and will remain abroad during the present year.

J. G. Hibben, professor of logic in Princeton University, is spending the year abroad and is at present in Strasburg.

Professor George T. Ladd, who holds the chair of philosophy at Yale University, has returned to the United States after a year's absence spent chiefly in Japan and India, where by special invitation he delivered lectures on philosophy and education at a number of the leading universities.

The Duke of Abruzzi, returning from his Arctic expedition, reached Naples on September 17th, and was met at the station by the King of Italy. He was welcomed with much enthusiasm. The London *Daily Express* states, on what authority we do not know, that the Duke of Abruzzi and Nansen will join in a North Polar expedition.

Dr. Alfred Stillé, formerly professor of the theory and practice of medicine at the University of Pennsylvania, has died at the age of eighty-seven years. He was the author of numerous works on medicine.

Professor Johann Kjeldahl, director of the chemical and physiological laboratory, Alt Karlsberg, near Copenhagen, was drowned recently while trying to save the life of a child. He is known for the method of detecting nitrogen to which his name has been attached.

The death is announced at the age of seventy-three years of Dr. Friedrich Griepenkerl, professor of agriculture in the University of Göttingen.

Dr. A. Graham Bell in his address as president to the Board of Managers of The National Geographic Society referred to the desirability of securing for the Society a building in Washington in which to establish the national headquarters. Mr. Bell stated that the plans for the proposed Memorial Building to the late president, Hon. Gardiner Greene Hubbard, are gradually taking form and assuming a practicable phase, and it is not unlikely that a Memorial Building may be erected this year and offered for the use of the Society. It is proposed that the building should contain a few small rooms that could be used as offices, a library and map-room, and a hall or meeting place sufficiently large to seat about 100 people. This would accommodate the Board of Managers and committees of the Society, and also permit of small scientific meetings of the Fellows of the Society. The Memorial Building, if erected, will place the Society in a much better position to receive the International Congress of Geographers, which has been invited to assemble in Washington under its auspices. Everything seems favorable to the establishment of the Society upon a permanent basis, and it only remains to take the necessary steps to convert the Society into a really national organization with national representation.

The seventy-second Congress of German Men of Science and Physicians, as we have already announced, met on September 17th at Aix-la-Chapelle. The Congress, as we learn from the *British Medical Journal*, contains 38 Sections; 17 are devoted to more or less non-medical subjects, such as natural history, geology, geography, education, etc., the remaining 21 dealing with all the special subjects of medicine, including balneology, accidents, history of medicine and medical geography, and finally veterinary matters. Several large buildings are devoted to the business of the sections, and there is a strong muster of about 2,000 German-speaking scientists, including many whose names are well known outside their respective countries. At the opening meeting the usual speeches of welcome were delivered by the Mayor and others, and the introductory addresses this year were by arrangement devoted not only to giving a retrospect of the subject, but a sketch of its development during the nineteenth century. Dr. J. H. van't Hoff (Berlin) spoke on the 'Development of the Exact Natural Sciences' (natural history, chemistry, and allied subjects). Dr. G. Hertwig (Berlin) delivered an address on the 'Evolution of Biology,' in which, after relating anatomical discoveries, he came to the large question of the natural origin of the organic world. He considered that Darwin's theories as to inheritance and natural selection still rested on the uncertain basis of hypothesis. He pointed out, however, that the difficulty arose from the absence of sufficient prehistoric records, and expressed his agreement with the opinion of Huxley that Darwin's teaching as to evolution will survive, apart from his principles of selection. Professor Naunyn (Strassburg) gave an address on the 'Evolution of Medicine,' connecting the progress of the science with the names of the German Schwann, the Frenchman Pasteur, and the Englishman Lister. The fourth and last address was given by Professor Chiari (Prague), whose subject was the 'Evolution of Pathological Anatomy.' As the founders of this science he mentioned Morgagni, Baillie, and the latter's pupils. The sections began their work on September 18th. An exhibition of scientific apparatus, drugs, foods, etc., was held in connection with the Congress. Some 300 to 400 papers were announced to be read, the Congress occupying five days in all.

The annual meeting of the British Iron and Steel Institute opened in Paris on September 18th and 19th under the presidency of Sir William Roberts-Austin. In addition to the address by the president, there were ten papers on the program. It was announced that Mr. Andrew Carnegie had given to the Institute the sum of £6,500 for the purpose of founding a medal and scholarship to be awarded for any piece of work that may be done in any works or university, and to be open to either sex. The details were to be left to the council of the Institute to settle. Mr. William Whitwell has been elected president of the Institute for the next two years.

Mr. Andrew Carnegie has intimated to the Greenock Town Council his intention of presenting £5,000 to the town to assist in the establishment of a free public library.

The Philosophical Faculty of the University of Göttingen has proposed the following subject for prizes on the Benecke Foundation: A critical investigation, based upon experimental research, of those complex chemical compounds, which cannot be explained upon the ordinarily received theory of valence, or can be so explained only by a forced interpretation of the theory. This investigation should take special cognizance as to how far the phenomena of molecular addition play a part in the formation of these compounds and as to whether it is possible to formulate a comprehensive theory of these complex compounds. The first prize is 3,400 Marks, and the second prize, 680 Marks. Papers in competition must be written in a modern language, and be accompanied by a sealed envelope containing the name, a motto on the outside of the envelope corresponding to the same motto on the paper. They should be sent to the Faculty of the University of Göttingen, not later than August 30, 1902.

We learn from the *Experiment Station Record* that the Russian Government has made provision for a commissioner of agriculture for each of the twenty governments of the Empire. They will have charge of all public measures relating to agriculture and rural affairs and will exercise supervision over the local agricultural institutions maintained by the government.

The third Pan American Medical Congress will be held at Havana from December 26th to 29th.

The Jury of Final Appeal of the Paris Exposition has finished its work, and it appears that in all the United States has received 2204 awards; Germany, 1826; Great Britain 1724, and Russia, 1493. Germany, however, received more grand prizes than the United States—236 as compared with 215.

The secretary of a British anti-vivisection Society has complained to the Department of State regarding the experiments by Dr. Noel Patton in which animals were deprived of food. Sir Matthew Ridley refused to prosecute the case, and was unwilling to give an opinion as to whether such experiments came within the provisions of the anti-vivisection Act.

At the Bradford meeting of the British Association, Mr. Glazebrook, the director of the National Physical Laboratory, presented a report on the construction of practical standards for use in electrical measurements, in which it was recommended "that a particular sample of platinum wire be selected, and platinum thermometers be constructed therefrom to serve as standards for the measurement of high temperature, and that Mr. Glazebrook and Professor Callendar be requested to consider the details of the selection of wires and construction of thermometers for the above purpose." It was announced that the sub-committee had secured specimens of a sufficiently pure platinum, and that some recently constructed thermometers had been tested at the National Physical Laboratory. During the summer a very full comparison had been made of the unit of resistance coils, and that these coils had been compared with some belonging to the Board of Trade and the Imperial Reichsanstalt of Berlin, and also with resistance tubes prepared by M. Benvit in 1885, which were in the possession of the director of the National Laboratory. Considerations of temperature had deferred the completion of these comparisons, but further observations would be made. Some advance had been made during the year with the construction of the Ampère balance. Material pecuniary assistance had been received from Sir Andrew Noble.

The American Consul at Frankfort sends to the Department of State an abstract of an article in the *Elektrotechnische Zeitschrift* discussing the progress made in the use of single lines for telegraphing and telephoning simultaneously. After describing the Rysselberghe system of attaining this end, and fully explaining the important part played by condensers, the writer describes a modification of the system recently introduced by the Telephone Works of Hanover, which, it seems, has already been adapted to a number of large installations, including the Berlin fire-brigade service. There are fifteen brigade stations in Berlin, each of which is served by a special network of fire alarms. From these stations underground wires radiate in all directions, each wire being connected with a great number of alarm pillars. The alarms are arranged for automatic working, and to each is fitted a key for telegraphing to the station. As it is, however, a very great advantage to be able to maintain during the progress of the fire, a good connection between the alarm pillars nearest the fire and the brigade station, exhaustive trials have been made with a specially adapted telephone constructed by the above-mentioned firm, which have resulted in the general introduction of the same. To the Morse apparatus at the station a stand is attached from which a microtelephone fitted with a battery switch and a second receiver are suspended. The remaining apparatus is inclosed in a flat box and placed under the table. This box contains an induction coil, a condenser and a circuit key. As it would be expensive to equip each of the fire-alarm posts with telephone apparatus, a portable set is used, which may be attached to the posts by means of a plug and socket provided for the purpose. Such a portable set is carried by each of the brigade carts, there being some eighty now in use. The brigades' cycles are also equipped with sets which are very compact in design. Experience with the system has shown that the switching in of the telephone apparatus in no way influences the telegraph service. During simultaneous telegraphing and telephoning a slight knocking is perceptible in the telephone, which, however, does not destroy the audibility.

UNIVERSITY AND EDUCATIONAL NEWS.

The will of the late Dr. J. M. Da Costa, of Philadelphia, contains generous public bequests, including $5,000 to the University of Pennsylvania and $5,000 to the College of Physicians. His medical library is given to the College of Physicians and his medical museum to the Jefferson Medical College.

Mr. F. Ravenscroft has given 2,000 guineas to the Birbeck Institution, London. Part of the money has been used to provide a metallurgical laboratory.

The Massachusetts Institute of Technology has established a special course in electro-chemistry which aims "to provide the education requisite for the investigation of the many new problems which the development of novel processes is certain to bring forth, and also to impart the professional skill requisite for the installation, testing, and operation of apparatus and machinery by which electrical energy is applied in chemical, metallurgical, and allied processes. The instruction given, moreover, is of such a broad character, particularly in electricity and chemistry, that a student completing this option should be well prepared to undertake various lines of electrical or chemical work other than electro-chemistry."

On September 29th President Schurman reported a registration of 2,900 students in Cornell University. Sibley College is reported by the director to have 625 to date.

The 'Cambridge University Calendar' shows a slight decrease in the number of students as compared with the preceding year. The following table shows the number of students at each college, etc., and also the number who have proceeded to the degree of M. A. or some higher degree and are members of the Senate and of those who have taken their first degree:

College.	Members of the Senate.	B.A., LL.B., etc.	Under-graduates.	Total.
Trinity	2,160	839	676	3,675
St. John's	984	328	237	1,549
Gonville and Caius	411	257	222	890
Pembroke	317	280	226	823
Emmanuel	364	209	177	750
Christ's	360	208	168	736
King's	312	253	143	708
Trinity Hall	232	184	190	606
Clare	276	133	185	594
Jesus	211	79	112	402
Corpus Christi	257	83	59	399
Peterhouse	209	72	55	336
Queens'	139	81	98	318
Sidney Sussex	133	99	72	304
St. Catharine's	103	70	73	246
Magdalene	123	41	48	212
Downing	98	59	52	209
Selwyn Hostel	57	118	84	259
Non-collegiate	15	47	108	170
Members of Senate not on college boards	202	0	0	202
	6,963	3,440	2,985	13,388

At Princeton University Elmer H. Loomis has been made full professor of physics and E. O. Lovett full professor of mathematics. Professor Lovett is spending the year abroad.

Francis M. Thorpe, instructor in the Wharton School of the University of Pennsylvania, has been called to the chair of commerce and economics in the University of Vermont, recently endowed by Mr. John H. Converse.

Dr. Victor Uhlig, professor of mineralogy in the Technical Institute at Prague, has been appointed professor of paleontology in the University at Vienna.

A chair of hygiene and bacteriology has been established in the University of Athens. Dr. Savas, formerly staff surgeon of the Greek army, has been appointed professor and director of the Hygienic Institute.

Mr. L. R. Wilberforce, demonstrator in physics at the Cavendish Laboratory, Cambridge, and university lecturer in physics, has been appointed to the Lyon Jones chair of experimental physics at University College, Liverpool, vacated by acceptance by Dr. Oliver Lodge of the principalship of the University of Birmingham.

SCIENCE

Friday, October 12, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

*THE REVIVAL OF ORGANIC CHEMISTRY.**

Custom has placed upon the presidents of the Chemical Society the duty of delivering an annual address, and in pursuance of that duty I spoke to you last year upon the 'Revival of Inorganic Chemistry.'† I endeavored to show that this branch, so long overshadowed by organic chemistry, so long but little more than a collection of almost unconnected facts, subordinate to analytical and technical chemistry and to mineralogy, is gradually, and especially since the discovery of the Periodic Law, rising to the rank of an independent and important division of our science.

I have chosen for my present topic one which is complementary to the former, 'The Revival of Organic Chemistry.' I may perhaps appear to most of you almost facetious in speaking of the revival of a branch of chemistry which has been in rapid growth for so many decades, which never counted a greater number of adherents than to-day, and which, regarded from the systematic standpoint, is not only the most highly developed portion of chemistry, but also one of the most highly developed of all the sciences. Yet I believe that the use of the term *revival* is justifiable. I do not share the opinion which appears to be held by some inorganic and physical chem-

* Annual Address of the President of the Chemical Society of Washington, October 11, 1900.

† Science, April 28, 1899.

ists, that organic chemistry is approaching the condition in which it will have ceased to afford a profitable field for research, and in which it must be turned over for exploitation to the technologist. I believe that never in its history has there been a time when more directions for truly original work were visible than to-day, and if I have urged the claims of inorganic chemistry to greater recognition, I do not believe that this should be accomplished by abandoning the investigation of carbon compounds, but rather by increasing the number of workers. To those trained in the older organic chemistry of twenty years ago, but who have not followed its recent development, it may indeed seem that formula worship is still supreme, and that further evolution, in a theoretical sense, has been arrested. It cannot be imagined, however, in these times of progress, when even analytical chemistry is beginning to lose its purely empirical nature, and to assume a scientific aspect, that the organic chemist will be content with indefinitely developing the ideas inherited from the past, without originating, or at least assimilating essentially new conceptions. Two courses are open to him if he would remain a scientist: the one, to admit that carbon chemistry has reached its limit of development, and to abandon it for other more profitable fields; the other, to seek new directions of work in this field, to devise new methods, suggest new hypotheses and apply principles originating in other provinces of science. My present object is to point out some of the newer lines of work which appear to me to be particularly important, some of which are already well known, while the significance of others, while doubtless apparent to some, does not yet seem to be generally recognized or insisted on.

Every chemical student is more or less familiar with the remarkable theoretical growth of carbon chemistry between 1830 and 1860, leading up to the valence hypothesis and the hypothesis of the linkage of the atoms, and culminating in the fully developed structural formula, representing schematically the relation of the atoms in organic molecules. This was followed by a period almost devoid of theoretical developments, but characterized by intense activity in devising synthetical methods and applying them to building up new or already known compounds, or in systematically decomposing complex bodies, with the sole object of establishing their structural formulas. The beautiful researches based on the benzene ring theory of Kekulé, the synthesis of alizarine by Graebe and Liebermann, and of indigo by Baeyer, brilliantly conceived and executed as they were, threw not a single further ray of light on the deeper problems of chemistry, and were of much less theoretical significance than the discovery, in 1830, of the transformation of ammonium cyanate into urea. The determination of the structural formula became the final end of nearly all organic chemical research, in so far as this was prompted by scientific rather than practical motives.

The structural formula once developed, the compound possessed little further interest, except in so far as its transformations could lead to the setting up of similar formulas for other bodies. When I was a student of organic chemistry, in the eighties, formula worship was rampant. Neither in America nor in Germany was I led to believe that organic chemistry could have any other aim and end than making new compounds and studying their constitution. A new compound! How the soul of the young investigator thrilled with joy when his substance showed a new percentage of carbon and hydrogen, a new melting or boiling point; this was something no god nor mortal had yet beheld. The constitutional formula was then deduced, if possible; if impossible, then at least one which it might have without violating the laws of valency, the substance was placed in a specimen tube, labeled with its formula and laid away. It was true that two Norwegians, Guldberg and Waage, had claimed to have discovered what they called the law of mass action, Wilhelmy and Menschutkin had studied the time required in certain reactions, a physicist named Hittorf had spent much time in studying the electrical conductivity of solutions, while van't Hoff, a chemist in a Dutch veterinary school, had suggested a theory intended to account for the differences between dextro- and lævo-tartaric acids and similar bodies, which was alluded to as a chemical curiosity, but none of these things were thought worthy of serious consideration by the organic chemist, who was blinded by the really beautiful system of carbon chemistry, and wrapped in dreams of structure. The physiological chemist likewise, failed to realize the fact that he must get beyond the question of constitution before he could accomplish any real progress in his science. I was urged by a well-known chemist with physiological proclivities to take up the study of the proteids. "What we want," said he, "is a sort of map or chart showing the constitution of each of these bodies." The synthesis of uric acid was hailed as a valuable contribution to physiological chemistry, although it did not establish its structure; was effected under conditions impossible in the organism and gave no clue whatsoever to its mode of formation in the body. The term 'formula artificer' (Formelkünstler) applied in a somewhat derogatory sense, fairly expressed, as it still does, the state of mind of those engaged in this kind of work. I have often wondered why chemists persist in speaking of *discovering*, rather than of *devising* a new compound. Organic chemistry might well have been defined as the art of devising new combinations of carbon atoms, for although using scientific methods, the compound maker, as far as his appreciation of his own work was concerned, was rather to be compared with a designer or architect than with his fellows in other branches of science.

Of course, it is far from my intention to belittle the preparation of new compounds or the study of structure. These are valuable pioneer work and necessary precedents to the solution of many problems of chemistry, but they should not be made the final aim of research, as the organic student has so often made them. The ease with which new carbon compounds are made is illustrated by the fact that while the first edition of Richter's *Tables*, which appeared in 1883, embraced 16,000 different organic substances, the new edition, just published, enumerates 75,000, and this number might easily be tripled or quadrupled without the application or discovery of a single new principle of chemistry. It is clear, then, that the honor of adding another to these 75,000 cannot be very great, unless the new body be one calculated to throw light on unsolved problems. The nature and limitations of the structural formula, too, are so well known, that mere variations on the theme cannot be of any great value.

The rapid development of formula worship, and by this term I mean, not the study of structure in itself, which is perfectly legitimate, but the making it the sole aim of research, was due partly to the ease with which the brilliant methods and conceptions of Frankland, of Kekulé and of Couper could be applied to nearly all classes of organic compounds and partly to the comparatively narrow training of chemists during this period. Science does not of necessity develop in a rational way; it grows along the lines of least resistance, whether or not these be those which a mature and broadly trained intellect would indicate as the best. The line of least resistance in organic chemistry was the synthetical direction, the direction requiring persevering application of a comparatively few methods and ideas, while progress in other directions was barred by the chemist's ignorance of subjects lying outside his special field. It has been but a few years that even the scientific chemist has been expected to know much more of physics than that required to comprehend his methods of molecular weight determination. The importance of physics in a chemical education was greatly underrated, and it is, therefore, not in the least surprising that the significance of such studies as those relating to mass action, reaction velocities, equilibrium, electrical conductivities, optical rotation and other provinces of modern physical chemistry should have been greatly underestimated or wholly ignored by the organic chemist, and that he should have become a man of one idea, unwilling even to take the time to open his eyes to the light which was beginning to be thrown on his field by those whose broader education enabled them to discern the future more clearly.

It is perhaps worth while to call attention here to the part which isomerism has played in the various steps forward which organic chemistry has taken. Before 1820, the different modifications of chromic oxide, of silica, of the stannic acids had been discovered, but attracted little attention. The correctness of the discovery of the isomerism of the silver salts of cyanic and fulminic acids by Liebig and Wöhler, in 1823, was even at first doubted. Once established, it become clear that the atoms composing the molecule could not be combined in an indifferent or chaotic fashion, but that, as suggested by Gay-Lussac, combination must take place in a definite and fixed manner, differing in the different isomers. It is to this conception that we owe the 'radical theory,' which assumed the presence in the molecule of groups of atoms having an independent existence and capable of being transferred without change from one compound to another, and, in short all the various theories of constitution which culminated in structural chemistry as represented by Kekulé. We shall presently see how a finer kind of isomerism led to the study of space chemisty, and still later, how isomerism lies at the foundation of the subject of tautomerism, which is of such importance at the present day.

The structural formula implies (if we may disregard the view of the few more cautious chemists who regard it as a reaction formula only) that the atoms are in each case linked together according to a definite plan, but it is purely diagrammatic, it says nothing about their relation in space; this may be fixed or nearly fixed, or it may vary as the Solar System varies, the plan remaining the same, but the relative positions of the component bodies changing entirely from instant to instant. Up to 1860 scarcely a chemist concerned himself in the least with the relative positions of the atoms or groups in space, and it was not till 1887 that the chemical mind became awakened to the importance of this question. A few earlier chemists, it is true, as Boyle, Wenzel, Wollaston, Gmelin, Laurent, had suggested the possibility of the existence of such definite relations, but the absence of any experimental basis for such speculations prevented their suggestions from having any positive results. It is about the year 1887, therefore, that I am inclined to place the beginning of the revival of organic chemistry.

The development of the conception of chemistry in space is inseparably bound up with the chemical and crystallographic study of tartaric and racemic acids, and with Biot's discovery of the rotation of the plane of polarization of light by certain dissolved organic compounds. The isomerism of tartaric and racemic acids was recognized by Gay-Lussac in 1826 and by Berzelius in 1830, but nothing in their observations indicated that this isomerism was in any way peculiar and of a finer kind than that existing in other cases. Still earlier, in 1815, Biot had found that tartaric acid and various other organic bodies, such as sugar, camphor, turpentine, possess the power of rotating the plane of polarization of light, and as this property is shown by them in the dissolved state, it was clear that it must be due, not to crystalline structure, but to intramolecular constitution. In 1841, de La Provostaye investigated the crystallography of tartaric and racemic acids and their salts without noticing any difference between the two series, while in 1844 Mitscherlich examined the double sodium ammonium salts of these acids crystallographically with the same result. Referring to the discovery of Biot that the tartrates are dextrorotary, the racemates indifferent, Mitscherlich says: "Nevertheless, the nature and number of the atoms, their arrangement and their distances apart are the same in both bodies."

In 1848, Louis Pasteur, who was then a chemical student just beginning independent work, turned his attention to the study of crystals as offering a possible assistance to him in his chemical researches. With no expectation of making a discovery, with a view to practice solely, he began by repeating de La Provostaye's work of seven years before, as far as it related to tartaric acid. He soon observed a fact which had escaped the former, this being that crystals of the tartrates possess certain hemihedral faces, and further that the hemihedrism is in the same sense in all the tartrates. Led by the observation of Hauy and Weiss, on the existence of right- and left-handed hemihedrism in quartz, of Biot, on the existence of dextro- and lævo-rotary quartz, and of Sir John Herschel, that the crystallographic difference of the two kinds of quartz is associated with a corresponding difference in the sense of their optical rotation, he undertook an investigation designed to ascertain whether in the various crystalline organic bodies possessing optical rotation in solution, this property is always accompanied by hemihedrism, and whether absence of the one implies corresponding absence of the other. He examined the crystals of the optically indifferent racemic acid and its salts; none of these showed hemihedrism. Mitscherlich had failed to observe the hemihedrism of the active sodium ammonium tartrate and found that its crystals differ in no wise from those of the corresponding inactive racemate. Herein was an apparent exception to the rule, and Pasteur, therefore, repeated Mitscherlich's work. He found the hemihedrism of the sodium ammonium tartrate which had escaped the eye of Mitscherlich, but he also found—and this is the observation which entitles him to be regarded as one of the founders of chemistry in space—that exceptionally the double racemate also showed hemihedral faces, but that while half of the crystals were hemihedral in a right-handed sense, the other half were so in the opposite sense.* Carefully separating the two kinds, dissolving them and placing the solutions in the polarimeter, he found, to his great surprise and delight, that the one solution was dextro-, the other lævo-rotatory. From the latter he prepared lævo-tartaric acid, the hitherto unknown isomer of common tartaric acid. Mixing the two acids in equal quantities, he regenerated the inactive racemic acid.

* The inversion temperature of sodium ammonium racemate is 27° C. (van't Hoff and van Deventer, *Zeit. physik. Chem.* 1, 173). Above this temperature the racemate is stable, below it, the mixed dextro- and lævo-sodium ammonium tartrates. Mitscherlich's failure to detect the facts afterwards observed by Pasteur may therefore have been due, not to erroneous observation, but to improperly selected temperatures.

This is an old story for us, but at that time it appeared highly improbable, and even Biot, the veteran discoverer of the optical rotation of dissolved organic substances, who had for twenty years vainly endeavored to convince chemists that in the study of this phenomenon was to be found one of the best means of investigating molecular structure, entertained strong doubts as to its accuracy. As an illustration of scientific skepticism, I may quote Pasteur's own words, relating to Biot's reception of his discovery:* "He (Biot) summoned me to his laboratory, in order to have me repeat the various experiments under his own eyes. He supplied me with racemic acid, which he himself had examined and had found to be optically inactive. I prepared in his presence the sodium-ammonium double salt, for which he wished to furnish even the soda and ammonia. The solution was set aside in his laboratory to evaporate slowly, and after 30–40 grams of crystals had formed, he again summoned me to the Collège de France to collect the dextro- and lævo-rotatory crystals, and separate them according to their crystallographic character, requiring me to repeat the assertion that those which I placed at his right hand were dextro-rotatory, and those at his left hand lævo-rotatory. When this was done, he said that he himself would carry out the rest. He carefully prepared the solutions and at the moment when he was about to observe them in the polarimeter he called me again into his room. He first brought into the apparatus the more interesting solution, that which should rotate towards the left. Without making the reading, merely by viewing the shades of color on the two halves of the field of vision, he recognized the presence of distinct lævo-rotation. Then the old man, visibly affected, grasped my hand and said, 'my dear child, I have loved science my whole life so much that I hear my heart beating for joy.'"

*Ostwald's Klassiker, No. 28, p. 14. This contains Pasteur's own account of his observations.

Pasteur was able to give but a vague, yet true explanation of his observations. He attributed this physical isomerism to a sort of asymmetry of the molecule, the two kinds being identical in every respect except that they cannot be made to coincide; they are like an object and its reflection in a mirror, the right and left hand, or a right- and left-handed screw. In his opinion, the asymmetry was caused by the action of forces peculiar to the organism.

Pasteur's discovery waited long before exercising a perceptible influence on the course of chemical research. Kekulé's *Lehrbuch*, published in 1866, describes the facts, but makes no mention of Pasteur's theoretical views. The investigations of Wislicenus, on the lactic acids, published in 1869, showed that four of these exist (β oxypropionic acid and two optically opposite forms of α oxypropionic acid with their racemic combination), while the structure theory indicates but two. Without giving a more concise explanation, he suggested that the difference of the acids is a geometrical one, and called this kind of isomerism *geometrical isomerism*. It is curious that at even this date Wislicenus makes no mention of Pasteur's discovery of the enantiomorphic tartaric acids or his theory of molecular asymmetry, although the facts were precisely analogous, and the explanation a more definite one than his own.

Pasteur's conception of molecular asymmetry, first stated, I believe, in 1860, had to wait until 1874 before assuming a form sufficiently definite to admit of application to the theory of structure. In this year there appeared independently and almost simultaneously two publications of essentially similar nature, the one by Le Bel in Paris, the other by van't Hoff, then professor in Utrecht. Le Bel acknowledged his indebtedness to Pasteur, while van't Hoff made no special mention of him and proceeded to develop his theory on *à priori* grounds, though he has elsewhere told us that his interest was aroused by Wislicenus' discovery of the physically isomeric lactic acids. Beginning with the assumption that the four valences of the carbon atom are directed towards the apices of a tetrahedron, van't Hoff showed that if any two of the four combined atoms or groups are identical (Caabc) but one form can result, while if they are all different (Cabcd) there must result two forms, identical in so far as their plane structural formulas are concerned, and identical in all chemical and physical respects, save that the one is to the other as an unsymmetrical object and its reflection in a mirror; they would constitute right- and left-handed figures, their influence on polarized light and on the form of the crystal would be the same, but in opposite senses, that is, they would be dextro- and lævo-rotatory, and if showing hemihedrism, this, too, would be opposite in the two forms. Proceeding to apply this hypothesis, he showed that every optically active organic compound, the constitution of which was then known, contains one or more such asymmetric carbon atoms, carbon atoms combined with four different atoms or groups; the dextro- and lævo-tartaric acids are identical when the ordinary formulas are considered, but different when the space relations are taken into account. It was further shown that two or more asymmetric carbon atoms in the same molecule might reinforce or neutralize each other with respect to rotatory power, in the latter case giving bodies like inactive tartaric acid, which differs from racemic acid in not being separable into optical antipodes.

Van't Hoff further applied his theory of the tetrahedral carbon atom to other obscure cases of isomerism, found only in bodies having doubly united carbon atoms, such as fumaric and maleic acids, which are not chemically identical, but the interpretation of which on the current views of structure had not been satisfactorily accomplished. Fittig regarded fumaric acid as

$$\begin{array}{l}\mathrm{CH.CO_2H}\\ \| \\ \mathrm{CH.CO_2H}\end{array}$$

and the isomeric maleic acid as

$$\begin{array}{l}\quad\mathrm{CH_2.CO_2H}\\ \quad\;| \\ =\mathrm{C{-}CO_2H}\end{array},$$

the latter formula, however, not being in harmony with the facts, while Anschütz held maleic acid to be

$$\begin{array}{l}\mathrm{CH.C(OH)_2}\\ \|\qquad >\mathrm{O} \\ \mathrm{CH.CO}\end{array}.$$

On van't Hoff's hypothesis, the doubly combined carbon atoms are incapable of free rotation, the combined groups or atoms being, therefore, compelled to retain their relative positions, thus giving stability to the two configurations

$$\begin{matrix}a\\b\end{matrix}\!>\mathrm{C}=\mathrm{C}<\!\begin{matrix}a\\b\end{matrix} \quad\text{and}\quad \begin{matrix}a\\b\end{matrix}\!>\mathrm{C}=\mathrm{C}<\!\begin{matrix}b\\a\end{matrix}$$

We have thus two distinct types of geometrical isomerism; in the one, the type with asymmetric carbon atoms, the chemical properties are identical and likewise the physical, except in so far as they involve space relations, as optical rotation and hemihedrism; in the other, that of the doubly united carbon atoms, the chemical properties, while not absolutely identical, are so nearly so that they can be expressed by the same structural formula of the old style.

Van't Hoff and Le Bel's explanation of physical isomerism long attracted but little attention among chemists, partly because such cases were then comparatively rare, partly because of the inertia of the chemical mind, which preferred to seek an explanation in new forms of plane structural formulas, or which simply ignored the facts, much as the inorganic chemist long ignored the existence of double salts, which did not conform to his notions of what valency should do. The theory, however, at once found a warm advocate in Johannes Wislicenus, whose mind had been prepared by his investigation on the lactic acids, but in other quarters it met with open opposition. Among its opponents was the illustrious but pugnacious Kolbe, whose words * I cannot refrain from quoting, both because they are extremely characteristic of his style of criticism, and because they were directed towards a man who has since won the highest renown as a chemist, and towards a theory which has now earned an accepted place in science.

"In a recently published article under the above title,† I have denoted, as one of the causes of the present retrogression of chemical investigation in Germany, the lack of general, and at the same time fundamental chemical training, under which not a small number of our chemical professors labor, to the great disadvantage of science. The result is the prevalence of a vegetation of apparently learned and intellectual, but in reality trivial and soulless, natural philosophy, which, set aside fifty years ago by the exact investigation of nature, is again being hauled forth by pseudo-scientists from that rubbish room which contains the wanderings of the human mind, and which, like a wench dressed in the height of fashion and freshly painted, it is being attempted to smuggle into good society in which it does not belong.

"Let him to whom this fear seems overdrawn, read, if read he can, the recently published brochure, bristling with the play of fancy, of Messrs. van't Hoff and Herrmann, on the 'Position of the Atoms in Space.' I should ignore this, as I have many others, had not a reputable chemist* taken it under his protection and warmly recommended it as a valuable production.

"A certain Dr. J. H. van't Hoff, at the Veterinary School in Utrecht, has, as it appears, no taste for exact chemical research. He has considered it more convenient to mount his Pegasus (evidently borrowed from the Veterinary School), and to announce, in his 'Chimie dans l'espace,' how, from the chemical Parnassus, reached in his bold flight, the atoms of the universe are seen to be arranged. * * *

"To criticise this brochure even half-way is impossible, because the fancies contained in it are wholly without foundation in fact, and absolutely incomprehensible to the sober investigator. But to get an idea of what floated before the minds of the authors, it will suffice to read the two following sentences. The brochure begins with the words: 'Modern chemical theory has two weak points; it speaks neither of the relative positions of the atoms in the molecule, nor of the nature of their motions.' The second sentence reads: 'In the asymmetric carbon atom we have a medium which is characterized by the screw-like arrangement of its smallest parts, the atoms!' * * *

"It is characteristic of the present uncriticising and criticism hating age that two practically unknown chemists, the one in a veterinary school, the other in an agricultural institute, confidently pass judgment upon the highest problems of chemistry, which in all probability will never be solved, especially the spatial relations of the atoms, and undertake their solution with an assurance which sets the true investigator in positive amazement. * * *

"Wislicenus herewith announces that he has abandoned the ranks of exact investiga-

* Zeichen der Zeit. *Journ. prakt. Chem.* N. F. 15. 473.

† *Journ. prakt. Chem.* N. F. 14. 268.

* Wislicenus.

tors, and has gone over to the camp of the natural philosophers of unhappy memory, which but a thin 'medium' separates from the spiritualists."

Upon this criticism van't Hoff remarks, in a later work,* "But ten years have passed—Kolbe is dead, and by a strange freak of fate it is Wislicenus who has succeeded him in the University of Leipzig," to which we may add, that after twenty-five years, the Utrecht horse doctor has become professor in the University of Berlin, and the chemical world has united in doing him honor upon the twenty-fifth anniversary of his doctorate.

Time is wanting to do more than allude to the interesting 'tension theory' of von Baeyer, dating 1885, which, by adopting van't Hoff's conception of the tetrahedral arrangement of the carbon valences, and assuming that these tend to maintain their relative positions with considerable force, like elastic springs, offered an explanation of the relative stability of the polymethylene rings and the instability of the polyacetylene compounds.

The first strong impulse to the study of the space relation of carbon compounds was given by Johannes Wislicenus in 1887, by his paper on 'The Spatial Arrangement of the Atoms in Organic Molecules, and its Determination in Geometrically Isomeric Unsaturated Compounds.'† In this paper the subject was treated essentially as it had been twelve years before by van't Hoff, but with important extensions, covering the lactones and anhydrides. After the appearance of this epoch-making work, stereochemistry was no longer a scientific curiosity; it at once became the fashion, and has so remained ever since. Many speculations have appeared, but few have obtained much foothold, and the stereochemistry of to-day, so far as it concerns carbon, is essentially that of van't Hoff, Le Bel and Wislicenus. The classical researches of von Baeyer on the hexahydrophthalic acids are based essentially on extensions of the theory of the geometrical isomerism of bodies of the ethylenic type and have contributed not a little to its confirmation. The preparation of stereoisomers of both types is now a matter of almost daily occurrence.

Unquestionably the greatest achievements of stereochemistry are to be found in Emil Fischer's magnificent researches on the sugars. If to explain old facts and to lead to the discovery of new ones be any test of the truth of an hypothesis, then the applicability of the theory of the asymmetric carbon atom to the carbohydrates affords a very strong presumption in its favor. The stereochemistry of the sugars might by itself form the subject of many lectures. Not only were the relations of the already known sugars satisfactorily explained, but the synthesis of whole new groups was effected, the configuration of each of which was determined.

Pasteur discovered the three chief methods which are still used for separating an optically inactive mixture into its active components, namely, (1) separating by selection the two kinds of hemihedral crystals corresponding to the dextro- and lævo-rotatory forms, (2) separation by means of alkaloid salts, the alkaloids being themselves optically active and forming with the two constituents of the racemic mixture two salts which are not enantiomorphic and therefore differing chemically and physically, one being less soluble than the other and (3) separating by means of fermentation, the fermenting organisms frequently showing a tendency to destroy one of the forms while leaving the other un-

* Dix années dans l'histoire d'une théorie, p. 21.

† Ueber die raümliche Anordnung der Atome und ihre Bestimmung in geometrisch-isomeren ungesättigten Verbindungen. Abhand. d. K. Sächs. Gesellsch. d. Wiss. Bd. 24.

touched. The alkaloid and the fermentation methods are of the widest applicability, and the latter is especially important because of its bearing on vital phenomena. Pasteur showed that the micro-organism is able to attack one of the geometrically isomeric forms, while incapable of acting on the other. In his work on the sugars Fischer further demonstrated that this selective power is not to be ascribed to any peculiar vital property of the living cell, for the soluble ferments, the enzymes, have frequently the same selective power. This power he attributes to the existence of the proper molecular asymmetry in the enzyme, by virtue of which its molecule is able to come into proper relationship with the asymmetric molecule of the body to be fermented; with exactly the same constitution on the part of one of the reacting bodies, but with the opposite configuration, this relationship cannot be brought about and fermentation does not ensue; as Fischer expresses it, sugar and enzyme must be adapted to each other as lock and key. Lock and key may be made on the proper model, but only when the notches of the key are on the same side as the wards of the lock can they fit each other. From this it would follow that the form which is left unattacked during the fermentation with a particular enzyme should be decomposed by an enzyme having the same chemical formula but the opposite configuration.

In fact, the physiological significance of stereochemistry is so great that we do not yet begin to appreciate it. The carbohydrates all contain asymmetric carbon atoms, and the same is unquestionably true of the proteids, all of which are optically active; the enzymes, as bodies closely related to the proteids, probably possess molecular asymmetry. The different digestibility or assimilability of various carbo-hydrates and proteids may be partly due to the different space configuration of their molecules rather than to any specifically chemical cause. Fischer has suggested the possibility of synthesizing a sugar capable of assimilation by diabetics. The power of digesting cellulose and horny matter possessed by some animals may be due simply to the peculiar configuration of their digestive enzymes. The curious fact that dextro-asparagine is sweet, while lævo-asparagine is insipid, is doubtless due to the asymmetric structure of the active molecules of the taste buds. It is possible that a dextro-strychnine might be innocuous, a dextro-quinine a virulent poison.

It is well known that all asymmetric compounds produced by purely artificial methods consist of an optically inactive mixture of dextro- and lævo-rotatory forms in equal proportions; only nature is able to produce one form to the exclusion of the other; the chemist can do this only with the aid of a natural product such as an alkaloid or enzyme, itself active in one sense, or by intelligent selection, as where Pasteur separated the two tartrates. At present we can perceive no escape from the dilemma that in the synthesis of its optically active substances the organism either employs some ultra-chemical process, or produces them by chemical means through the agency of previously existing active substances. The latter alternation would lead us back to the existence of one-sided asymmetry in the very first organism of the series, the origin of which it is equally impossible to explain on chemical grounds. This interesting fact, pointed out by Japp * is regarded by him as indicating that something besides chemical and physical forces was concerned in the original production of life. The difficulty is a real one, and we still know of no better explanation than

* Address before Section 'B,' British Association for the Advancement of Science. *Nature*, Vol. 58, p. 452.

is suggested by the words of Pasteur:* "Is it not necessary, and also sufficient to assume that at the moment when the vegetable organism originates, an asymmetric force is active? * * * Do there perhaps exist such asymmetric activities, subordinated to cosmic influences in light, heat, magnetism, electricity? Are they associated perhaps with the motion of the earth, with the electric currents by which the physicists explain the magnetic poles of the earth? We are to-day not in the position to express even the least opinion on the subject."

Before we assume the existence of a vital force or other mysterious agency, however, to explain the difficulty, let us not forget the confidence with which Berzelius asserted the hopelessness of the problem of producing organic compounds from purely inorganic material.

Speculation on the space relations of the atoms has not been slow in extending itself to other elements than carbon. More especially has nitrogen occupied the attention of stereochemists. Many attempts to prepare geometrically isomeric ammonium compounds have been made, by introducing the substituting groups in different orders, without positive results. Within a year, however, Pope and Peachey † have succeeded in decomposing inactive α-benzyl-phenyl-allyl-methyl-ammonium into its dextro- and lævo-rotatory constituents by means of dextro-camphor sulphonic acid, thereby affording a proof of the existence of stereoisomeric compounds of pentavalent nitrogen, a discovery which, if confirmed by the preparation of other similar compounds, is of the very highest importance. Still more recently, the same chemists have obtained optically active compounds of tetravalent sulphur and tin. ‡

* Ostwald's Klassiker, No. 28, p. 31.

† *Journ. Chem. Soc.*, 75, 1127.

‡ *Journ. Chem. Soc.* 77, 1072; *Proceedings Chem. Soc.* 16, 42, 116.

More fruitful has been the hypothesis of Hantzsch and Werner originally suggested by the existence of physically isomeric oximes, and now applied by them to the compounds containing the group—N =N—. According to this view the triad nitrogen atom may be regarded as occupying one apex of a tetrahedron, the combined groups occupying the others, or in other words, the three valences of the nitrogen do not act in the same plane. In the case where the nitrogen atom is doubly united to another nitrogen or a carbon atom, free rotation is prevented, as in the case of doubly united carbon atoms, and we may have stereoisomers of the types

$$\begin{array}{c}\text{a—C—b}\\ \|\\ \text{c—N}\end{array} \quad \text{and} \quad \begin{array}{c}\text{a—C—b}\\ \|\\ \text{N—c}\end{array}$$

Benzaldoxime, for instance, exists in the forms

$$\begin{array}{r}\mathrm{C_6H_5.C.H}\\ \|\\ \mathrm{HO.N}\end{array} \quad \text{and} \quad \begin{array}{l}\mathrm{C_6H_5.C.H}\\ \|\\ \mathrm{N.OH}\end{array}$$

and diazobenzolhydroxide as

$$\begin{array}{r}\mathrm{C_6H_5.N}\\ \|\\ \mathrm{HO.N}\end{array} \quad \text{and} \quad \begin{array}{l}\mathrm{C_6H_5.N}\\ \|\\ \mathrm{N.OH}\end{array}$$

while according to Hantzsch, the isomeric nitramide and hyponitrous acid are simply

$$\begin{array}{r}\mathrm{HON}\\ \|\\ \mathrm{HON}\end{array} \quad \text{and} \quad \begin{array}{l}\mathrm{HON}\\ \|\\ \mathrm{NOH}\end{array}$$

It is quite possible that the Hantzsch-Werner hypothesis may also find an application in the study of the labile compounds of the organism. Still more recently, Werner has considered as stereo-isomeric a number of metal-ammonias and their derivatives, notably the platinum compounds

$$\begin{array}{c}\mathrm{Cl}\\ \mathrm{Cl}\end{array}\!>\!\mathrm{Pt}\!<\!\begin{array}{c}\mathrm{NH_3}\\ \mathrm{NH_3}\end{array} \quad \text{and} \quad \begin{array}{c}\mathrm{Cl}\\ \mathrm{NH_3}\end{array}\!>\!\mathrm{Pt}\!<\!\begin{array}{c}\mathrm{NH_3}\\ \mathrm{Cl}\end{array}$$

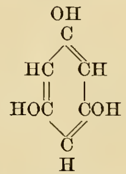
platosemidiamine chloride. platosamine chloride.

I have mentioned the latter examples as illustrating the tendency to extend the newer conceptions of the carbon atom to the atoms of other elements also. Whether we shall ever have a stereochemistry of all the elements is very questionable. As I shall point out presently, carbon compounds in general possess a kind of inertia, a tendency to retain their structure, the possibility of isomerism being due to this. At a higher level of temperature, ordinary structural isomers tend to assume the most stable form or system, while those isomers the existence of which depends on asymmetric carbon atoms tend to form a mixture composed of equal portions of both right- and left-handed forms; both dextro- and lævo-tartaric acids, for example, giving racemic acid on heating. That we do not find more cases of structural or of steric isomerism among inorganic bodies is perhaps due, not to their existence being inherently impossible, but to our working at too high a temperature, a temperature at which isomers are incapable of existence, lapsing at once into the most stable forms or into a mixture of structurally equivalent but geometrically opposite bodies, which, like the constituents of racemic acid, are identical in chemical and most physical properties, and which, existing in equal quantities, balance each other optically and crystallographically, like the two tartaric acids. The asymmetric tin atom shows great lability at ordinary temperatures. At a temperature much below zero, such steric and structural isomers may well exist independently. The investigation of this is but one of the many possibilities of low temperature work.

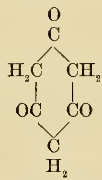
This brings us to a comparatively new and highly important branch of organic chemistry, the subject of *tautomerism*, and this, like stereochemistry, is an outgrowth of the subject of isomerism. Van't Hoff, in his remarkable, but little known book, 'Ansichten über die organische Chemie,' points out, as one of the reasons for the existence not only of the large number of carbon compounds, but also of isomers, the peculiar inertness of the union of carbon with itself and with other elements. Every one knows that in general the reactions of carbon compounds take place slowly, they form with difficulty and once formed are comparatively stable; there is a tendency to maintenance of the *status quo*. In the language of physical chemistry, we may say that carbon compounds usually tend to equilibrium with great slowness. They have a very small reaction velocity. By virtue of this property, the reason for which we do not know, the organic molecule, once formed, tends to maintain its individuality, hence the stability of isomers. Were it not for this, it would rapidly lapse to the system which is most stable, whether it be another simple body or a mixture. Just the opposite is characteristic of the inorganic molecule. We know a few inorganic isomers, it is true, but their occurrence is so rare as to excite comment. We are, for example, acquainted with three organic compounds $C_2H_5NO_2$, namely, ethyl nitrite $C_2H_5.ONO$, nitroethane $C_2H_5.NO_2$, and a less stable form of this, $CH_3.CH{=}NO.OH$, but we know but one nitrous acid and one series of metallic nitrites; we know but one sulphurous acid and one series of its metallic salts, while there are two series of organic derivatives, the sulphurous ethers and the sulphonates; but one hydrocyanic acid and one series of metallic cyanides, while there are two series of organic derivations, the nitriles and isonitriles; but one sulphocyanic acid with two series of organic derivatives, the sulphocyanates and the mustard oils. Such examples might be quoted indefinitely. Any one who has attempted to synthesize complex inorganic bodies by following the methods of organic chemistry must have been struck with the comparative rareness with which the desired results are obtained. In general, then, while organic isomers possess considerable stability, of the theoretically possible inorganic isomers expressed by any formula only one form is stable, and the others, if momentarily formed, tend to lapse spontaneously into this. As van't Hoff says, the carbon atom tends to confer on the molecule the power of storing up an enormous amount of energy, which power, for want of a better name, is termed the inertness of the carbon combination. It is this property, perhaps more than any other one fact, which distinguishes organic from inorganic compounds.

All organic isomers do not possess this power of maintaining their individuality to the same extent. We find every degree of transition from the stable to the labile, from those isomers which are not interconvertible at any temperature short of total decomposition, to those which change into each other upon the slightest provocation, such as slight elevation of temperature, fusion or solution, the presence of catalyzers or of bodies capable of reacting only with one form; from those whose individuality and stability are marked, to those where one form is stable, the other labile, and where the lability may vary to such an extent that in some cases the unstable form is easily obtained, in others only with the greatest difficulty, while in still others it is too unstable to exist at all under attainable conditions, and the isomerism disappears. It is the study of labile isomerism which, under the name of *tautomerism*, has attained such prominence in recent years. In the phenomena of labile isomerism, organic chemistry shows a distinct approximation to inorganic chemistry; the characteristic phenomena underlying tautomeric organic bodies and inorganic bodies is the same, namely, the tendency to pass easily from a labile to a stable form, in short, the absence, more or less marked, of the property which van't Hoff called inertness of union.

An extreme case of lability in one isomer is found in that of the hypothetical vinyl alcohol, $CH_2 = CHOH$. Reactions which theoretically should give this, in reality yield aldehyde, $CH_3.CHO$; the stability of the former is so slight that it passes at once, if formed, into the isomeric aldehyde. Baeyer obtained two ethyl-isatines, to which should correspond two isatines, while in reality but one exists. Allied to this is the behavior of phloroglucine, symmetrical trioxy-benzene, which, with acetyl chloride gives an acetate, indicating that its formula is



while with hydroxylamine it yields an oxime, which is explicable only on the assumption that it has the constitution



It is, therefore, impossible, by using the usual reactions for phenols and ketones, to ascertain to which of these groups phloroglucine belongs. Baeyer held that but one of the forms actually exists in the free state, the other, the pseudo-form, as he termed it, being too unstable for existence. Laar, on the contrary, held that in such cases both formulas are equally justifiable; that each molecule is constantly shifting back and forth between the two forms, each having but a momentary existence, and to such bodies he applied the term tautomeric.

The discussion on the nature of tautomeric bodies has been one of the hottest in the recent history of organic chemistry, and not altogether free from invective. Much of this could have been avoided had the organic chemist recognized that the problem is one in which the ordinary methods of organic chemistry find but little application, and then only with the greatest caution and judgment. The older methods are strictly applicable only to the more stable bodies. So impressed has he been with the inertness of the carbon union that he has failed to recognize that the laws of chemical equilibrium could have any place in organic chemistry. A certain compound may, for example, contain one of the two groups :

$$\begin{array}{c} =CH \\ | \\ -C=O \end{array} \quad \text{or} \quad \begin{array}{c} =C \\ \| \\ -COH \end{array}$$

The organic chemist assumed that it must be entirely the one or entirely the other, and was perplexed on finding that it reacted with a ketone reagent entirely in the former sense, and with a hydroxyl reagent entirely in the latter. To get around the difficulty, he was led to assume with Baeyer that only one of these actually exists in the free state, or with Laar, that each molecule is rapidly changing from the one form to the other and back again. The most elementary knowledge of reversible reactions would have taught him that the two forms must necessarily tend to a condition of equilibrium ; that the final product must be a mixture of both forms, but that equilibrium might lie at a considerable distance from both extremes, or very near to one ; that either form, if isolated, would tend with greater or less rapidity to the same condition ; that if he removed one constituent by converting it into another compound, the equilibrium would be disturbed, and more of the other form would undergo transformation and be removed from the sphere of action until conversion is complete, and that, therefore, conclusions based on purely chemical evidence were to be accepted with a grain of salt unless the two forms, by virtue of their slow velocity of transformation, could be isolated and studied. The application of physico-chemical methods nowhere in organic chemistry finds better opportunity than in just this field. In some cases the laws of the so-called 'condensed systems,' with definite inversion temperatures, are doubtless applicable. Hantzsch's researches on the nitro-hydrocarbons afford a good illustration of the superiority of physico-chemical methods. Nitroethane $C_2H_5NO_2$ is a good example of this class. Its constitution was assumed by its discoverer, Victor Meyer, to be $CH_3.CH_2.NO_2$, and it forms salts with alkali metals, in which the metal has been variously supposed to be united to carbon $CH_3.CHM.NO_2$ or to oxygen $CH_3.CH{=}NO.OM$; in the latter case it was necessary to assume either that the originally proposed formula of nitroethane is wrong, or that in forming a salt it undergoes intramolecular rearrangement. Hantzsch now applied the method of electrical conductivity. The aqueous solution of nitroethane is practically a non-conductor, and hence contains no ions, which would make it decidedly not an acid. If this solution be mixed with the equivalent of caustic soda, it at first shows only the conductivity due to the alkali ; gradually, however, this diminishes, indicating the slow formation of a salt, which, being the salt of a weak acid and therefore less dissociated than caustic soda, would conduct less. Were the nitroethane itself an acid, this effect should take place at once, as salts always form instantly or nearly so. If now just sufficient hydrochloric acid be added to convert the sodium nitroethane into nitroethane and sodium chloride, the solution at first shows a greater conductivity than is attributable to the sodium chloride alone ; the nitroethane, therefore, takes part in it, and as ordinary nitroethane is non-conducting, a body of different constitution must be present, and this is regarded as the true acid $CH_3.CH{=}NO.OH$; this, however, gradually loses its conductivity, being transformed into common nitroethane. Nitroethane is, therefore, capable of existing in two forms, the ordinary form, the stable pseudo-acid $CH_3.CH_2.NO_2$, gradually metamorphosing under the action of an alkali into the true acid $CH_3.CH{=}NO.OH$, which, stable as a salt, is labile in the free condition, gradually passing back into the pseudo-acid. In this, as in many other cases studied by Hantzsch, we find an intimate relation between tautomeric metamorphosis and ionization. Brühl has also recently pointed out a relation between tautomeric change and the nature of the solvent in which it occurs, the change from the enol to the keto form being promoted by ionizing solvents like water and alcohol, while non-ionizing solvents prevent or hinder it.

Passing from isomers in which both forms are stable, through various degrees of tautomerism, to where one of them is too labile to exist at all, at least under ordinary conditions, we reach the state of affairs prevailing among inorganic bodies. The tautomeric organic bodies are an approximation to the inorganic; their chemistry is an approximation to inorganic chemistry. Ostwald has recently suggested a division of chemical compounds into two great classes, the ionizing and non-ionizing.* These would, in general, correspond to inorganic and organic, but some of the inorganic bodies would be found in the non-ionizing groups, while besides the carboxylic acids, a few organic compounds will be found in the ionizing group. The tautomeric compounds would occupy the intermediate position. We learn from these considerations one reason why inorganic isomers are so seldom found. The labile tautomer the more readily transforms into the more stable form the higher the temperature. The reason that we do not have inorganic tautomers is simply because we are working at too high a range of temperature. Much below room temperature we shall probably find a field of inorganic tautomerism and isomerism as rich or richer than that presented by organic chemistry. There is no sharp line of demarcation between the two fields; the apparent difference results from the relatively greater inertness of the carbon union. If the methods of physical chemistry have hitherto found most application in inorganic chemistry, they are now being extended, in organic chemistry, first of all to those compounds which most closely resemble the inorganic, namely, the tautomers.

A word on the application of tautomerism in physiological chemistry. The organic constituents of protoplasm, in so far as they are essentially active, are, on Loew's theory, highly labile. The death of the protoplasm is at once accompanied by the transformation of its labile proteids into their stable forms. What it is that prevents this change taking place in life we do not know, yet it is evident that if we are to get light on the subject from the chemical side, it will not be so much by attempting to synthesize dead proteids, as by studying labile forms. I incline to the opinion, therefore, that the study of the phenomena of tautomerism is of the highest importance for physiological chemistry, and that physiological chemists will do well to turn their attention to this field.

It is usually assumed that no portion of organic chemistry is further removed from the inorganic than the study of the living cell. I am inclined to hold the opposite opinion. If, as I have suggested, the labile tautomeric compounds lie between the stable organic compounds on the one

*Grundriss der allgemeinen Chemie, 3te Aufl. S. 522.

hand and the stable inorganic on the other, then, too, the labile compounds of protoplasm occupy an intermediate position. The chemical phenomena of life, are as close to those of the inorganic as to those of the stable organic bodies. It is not so much by emphasizing the differences between carbon and the inorganic elements that we shall aid in the explanation of life as by looking for those features in which carbon approximates to the inorganic.

Hitherto the organic chemist has occupied himself mainly with the end-products of chemical reactions. With those important factors, the time and the yield, he has seldom concerned himself, further than to obtain the greatest possible yield in the shortest possible time, and he has reached this end by purely empirical processes. Now we know that most, if not all, reactions do not proceed to an end in the sense expressed by the chemical equation.* Every equation is true, not only when read from left to right but from right to left likewise ; there is always a state of equilibrium, lying between the two extremes, sometimes so far from each that the reaction is obviously incomplete, sometimes so near one extreme that for practical purposes it may be considered as coinciding with it, but in reality never absolutely does so. This state of equilibrium is influenced by the relative amounts or active masses of the reacting bodies, and is approached with a velocity varying from what is practically instantaneous to a slowness which can be measured only by ages. The ionized bodies reach equilibrium with exceeding rapidity, while undissociated substances, or those dissociating slowly, usually show a much smaller reaction velocity. The reactions of organic chemistry are to a great extent comparatively slow, and the equilibrium lies at a considerable distance from both extremes, hence the almost invariable wide deviation from the 'theoretical' yield of the desired products. It seems, therefore, that the study of reaction velocities and of the laws of equilibrium has a most important bearing on the work of the organic chemist, a study which he has been most tardy in taking up. The precious 'Ausgangsmaterial,' which he has spent months in preparing, is often wasted unnecessarily through ignorance of these laws, while in technical processes the case is no better ; this, too, quite apart from the contributions which could be made to physical chemistry by duly considering these points. As organic chemistry advances, relatively more and more attention will be devoted to the way in which the reaction takes place. In physiological chemistry especially is this important, because here it is not the final products themselves, as a rule, which are interesting, but the mode of their formation ; physiological chemistry is not a science of compounds, but a science of *processes* ; it is the most physico-chemical branch next to physical chemistry itself.

* This of course does not apply to the so-called 'condensed systems.'

Most important for organic chemistry and its applications is the study of the influence which certain substances exert on the course of a reaction, without being themselves permanently changed. Such phenomena have long been known, and to them the name *catalytic* was applied by Berzelius. The most obvious characteristics of such reactions are that the foreign substance, or catalyzer, is able to exert an influence altogether out of proportion to its quantity and that it remains unaltered at the end of the process. Such catalytic reactions are well known both in inorganic and in organic chemistry. In the former I may cite the well-known influence of small quantities of platinum in decomposing hydrogen peroxide, and the influence of the oxides of nitrogen or of spongy platinum in the formation of sulphuric acid, in the latter, the inversion of cane sugar by acids, and the phenomena of fermentation under the action of organized ferments or of enzymes. Various theories have been proposed to explain this phenomenon, but none of them seems to be universally applicable. Such theories as the temporary formation and splitting up of an additional product are not applicable in the case of the action of platinum on hydrogen peroxide. Moreover, we have not only positive or accelerating catalysis, but also negative or retarding catalysis, as in the preservation of hydrocyanic acid by traces of other acids, the retardation of the action of free oxygen on sodium sulphite by traces of alcohol, aldehyde and other organic substances, and the influence of palladium on sugar inversion. Such retarding actions can hardly be explained on any hypothesis yet offered. In recent years Ostwald has contributed greatly to the possible future solution of the problem by defining in what it consists. I have stated that every reaction proceeds to a state of equilibrium, with a certain definite reaction velocity; the element of time is, therefore, an important one in chemical changes. Ostwald has pointed out that the influence of the catalyzer is solely to modify the time factor. Reactions which may proceed ordinarily with a velocity so small as to be inappreciable in a lifetime, may be made by the presence of a catalyzer to take place in a few minutes or hours, and conversely, reactions ordinarily proceeding rapidly may be greatly retarded; but whichever occurs, the final state of equilibrium is the same, whether the catalyzer be present or not; it acts solely by modifying the reaction velocity. The knowledge of this important generalization is essential to any further progress. The importance for organic chemistry of a thorough study of catalysis can hardly be overestimated. I need only mention the important Friedel-Crafts reaction, in which anhydrous aluminium chloride is the catalyzer, and the reaction discovered by Beckmann. Probably a large portion of the chemical reactions known to us can be controlled by the use of a suitable catalyzer, being capable of acceleration or retardation at will, while many which do not occur with appreciable speed may be brought about in a limited time.

Especially important are the relations of catalysis to physiological chemistry. The unorganized ferments of the organism, the enzymes, are simply catalytic agents. Besides the well-known diastase, ptyalin, pepsin, and trypsin, there are many others, the importance of which is becoming more manifest every day. Since Buchner's discovery of zymase, the enzyme of the yeast cell, there seems to be a tendency to attribute nearly all the chemical processes of the organism, even oxidation, to enzymes. How far these views are correct is without the scope of the present subject, and I can allude to but a single recent discovery, the importance of which can hardly be overrated. A. C. Hill* has recently shown that the transformation of maltose into dextrose under the action of the enzyme maltase is in reality a reversible reaction. The equation is:

$$C_{12}H_{22}O_{11} + H_2O = 2C_6H_{12}O_6.$$

Before the reaction is complete, the action of the ferment ceases. If, on the contrary, we add the enzyme to a solution of dextrose, a portion of the latter is converted into maltose, the reaction being expressed by the above equation read from right to left. This is a striking confirmation of Ostwald's view that the catalyzer simply influences the rate, not the final condition, of the system. It has been suggested, and the view is a very plausible one, that in the living organism the very same enzymes which produce decompositions may under other conditions, in conformity with the law of

* *Journ. Chem. Soc.* (London), 73. 634.

mass action, reverse the reactions and bring about the corresponding synthesis. Every one knows that the amount of glucose in the blood is practically constant. When, through the assimilation of carbo-hydrates the glucose in the blood of the portal vein rises above the normal, the liver cells convert it into glycogen and store it away. As soon as the glucose in the blood begins to fall below the normal, as in the condition of hunger, the glycogen begins to break up and pass into the circulation. The decomposition of the glycogen is presumably due to the action of some enzyme, and it is entirely possible that it is the same enzyme which produces the synthesis as well as the decomposition. If by any process we could remove the maltose from our dextrose-maltose solution as fast as it is found, the transformation would finally be complete. The glucose-glycogen cycle is doubtless equally subject to the law of mass action.

Not only is the subject of catalysis of immense importance in the study of the normal physiological processes. In another respect it has an equally important bearing. In recent years the toxines have assumed a prominent rôle in pathology. How is it that a chemically insignificant portion of a substance may work such enormous changes in the system? This can hardly be attributed to chemical action in the ordinary sense. Much more likely is it that the action of the toxine is catalytic, simply consisting in producing rapidly changes which without it would require time of almost indefinitely great duration. I have spoken of negative or retarding catalysis. The antitoxine is, perhaps, not to be regarded as chemically neutralizing the toxine, but rather as a retarding catalyzer, as one tending to retard the changes which the toxine would otherwise bring about. Not only the toxines and antitoxines, but many drugs which exercise an influence altogether out of proportion to their amount, may act as catalyzers rather than strictly as chemical reagents. In fact, it is not impossible to imagine that the scientific medicine of the future may be influenced largely by a better understanding of this remarkable phenomenon of catalysis.

I would call the attention of those interested in the subject of enzymes and toxines and antitoxines to the recent remarkable paper of Bredig and von Berneck on inorganic ferments,* which although essentially inorganic appears to be an important contribution to physiological chemistry. Hydrogen peroxide is a substance particularly susceptible to the action of catalyzers; its decomposition is expressed by the equation

$$2H_2O_2 = 2H_2O + O_2.$$

Among the substances which bring about this decomposition without themselves undergoing any perceptible change are platinum, gold, silver, and many other metals, the peroxides of manganese, lead and cobalt and certain enzymes. Schönbein † says, speaking of the enzymes: "It appears to me to be a highly remarkable fact that all these fermenting or catalytic substances also have the property of decomposing hydrogen peroxide after the manner of platinum, a coincidence in various activities which must give rise to the suspicion that all depend upon a common cause." And elsewhere: ‡ "The results of my most recent investigations have only served to strengthen my conviction, long since expressed and often repeated, that the decomposition of hydrogen peroxide by platinum is the prototype of all fermentations." §

* *Zeit. physik. Chemie*, 31. 258.

† *Journ. prakt. Chemie* [1], 39. 334.

‡ *Ibid* [1], 89. 335.

§ Whether or not the view of Loew (personally communicated) be true or not, that the action of most enzymes on hydrogen peroxide is due to contamination by a special enzyme *catalase*, does not affect the significance of Schönbein's statement.

This action of platinum depends on its fineness of subdivision, and the difficulty of obtaining it of uniform quality in this respect has hitherto prevented the extension of experiments to the quantitative stage. Recently, however, Bredig has succeeded in obtaining a colloidal solution of metallic platinum by volatilizing the metal in an electric arc under water.* In this form the metal exposes an enormous surface, and is capable of being measured volumetrically, and the introduction of quantitative experiments is now possible. As little as one gram-atom † of colloidal platinum diffused through seventy million liters of water shows a perceptible action on more than a million times the quantity of hydrogen peroxide. What I wish to point out as especially interesting in the work of Bredig and von Berneck is this: they find that relatively minute portions of certain substances are able to inhibit the action of the platinum, and that these are substances which exert a markedly poisonous effect on the living cell and on enzymes. 1/345,000 gram molecule per liter of hydrogen sulphide already exerts a strongly restraining action, 1/1000 gram molecule of hydrocyanic acid per liter stops it entirely, and much less is able to retard it greatly. Carbon disulphide and mercuric chloride show a similar behavior. All of these substances are powerful poisons, and Bredig uses the very expressive word 'poisoning' with reference to their restraining action on the platinum; the platinum is 'poisoned' by hydrocyanic acid. Here we have a complete parallel with what is observed in the organism, and the parallel suggests a similar cause. The platinum acts towards hydrogen peroxide as a toxine, and the hydrocyanic acid as an antitoxine; or conversely, the metal may be compared with a natural ferment, the acid to a toxine which inhibits its action. It is not impossible that such studies, conducted with purely inorganic bodies, may help to throw definite light on the nature of immunity. At least we may hope that the study of catalysis, using simple substances under conditions admitting of exact measurement, will help to solve some of the deepest problems of physiology and dispel the ignorance which hides itself under the name of *vitalism*.

* *Zeit. Physik. Chemie.*, 31. 271.

† 193 grams.

Time is wanting to consider at any length the newer relations of organic chemistry to the theory of valency, especially interesting among which is the attempt of Werner to show that the supposed constant tetravalency of carbon is simply a particular phase of a general law of combination which does not come under the current valence doctrine. I may mention also that Nef regards many peculiar reactions as due to the existence of a bivalent condition of carbon, which we have hitherto recognized only in carbon monoxide. So important, indeed, is bivalent carbon, according to this savant, that he expresses the conviction "that in the chemistry of methylene is to be found a future exact scientific physiology and medicine and perhaps an explanation of the vital processes."* If this be true, physiological chemists cannot be too prompt in abandoning all other investigations for the study of bivalent carbon.

I have alluded to but a few features of the more recent progress of organic chemistry, and pointed out some of its newer tendencies. Slow as this revival is, there can be no question that the trend is away from a too narrow contemplation of the formula as a final end of study, and towards the deeper consideration of nature as the manifestation of energy. There can be no question that the continuity of all classes of chemical phenomena will be more and more recognized. Within a few years we have seen a new kind of chemistry come

* *Liebig's Annalen*, 298. 374.

into the field of view, narrowly called physical chemistry, but more properly designated as *general* chemistry, because its principles do not lie apart, but are the substratum of all chemical phenomena, and it is by the reaction of this on the special provinces that their true progress will be maintained. Who shall share the honor of contributing to this progress? Who shall remain behind pondering over antiquated problems? Let me recall to your minds the tenacity with which Priestley held to the doctrine of phlogiston, the persistence with which Berzelius fought the theory of substitution, the satire of Liebig on the discovery of the yeast plant, and the sneers with which Kolbe greeted the first announcement of the laws of stereochemistry. There are not wanting to-day those who take a similar position towards the newer principles and theories of general chemistry. Some of us are comparatively young, and in sympathy with the spirit of the time, but if the genius of Berzelius and Kolbe did not prevent their finally calling on the stream of progress to stop, how much more likely are we, as we grow older, to be found in a similar position if we once begin to yield to the spirit of indifference to that which does not most intimately concern us. As the truly scientific man is not he who limits his interest to a single province, but rather he who attempts to gain a rational comprehension of nature as a whole, so he only is truly a chemist in the highest sense of the word who is in sympathy with all branches of chemical investigation and with all progress, and who does not merely admit, with benevolent ignorance, but actually feels and sees that physical, inorganic, organic and physiological chemistry are not separate, but continuous with each other and with all nature. It is not enough that we occupy ourselves assiduously with researches in our chosen but often narrow field, if by much peering through the microscope of science we become myopic towards nature in general. We must, to use Kolbe's expression, frequently mount our Pegasus and soar to the heights of the scientific Parnassus. It is not the men who spend their lives in studying single groups of compounds or single phenomena, with interest in nought else, but those like van't Hoff, Ostwald, Fischer, and Hantzsch, who keep their minds open to light from all sources not the conservatives, but the radicals, who are lifting organic chemistry above the old fashioned and still fashionable structurism, and bringing about what I have called its *revival.*

H. N. Stokes.

THE WAIKURU, SERI AND YUMA LANGUAGES.

The area of the tribes of the Yuman family was visited and crossed in the earliest epoch of American exploration. These Indians became known through their large numbers and the fine exterior of their bodies, but chiefly through their spirit of opposition to the white man's progress. Scientific exploration of their country, settlements and languages began about 1850 on the Colorado and Gila Rivers. The area inhabited by them soon appeared to be largely in excess of what it had been supposed to be; for from San Luis Rey, on the Pacific Ocean, their territorial boundary extended south of the Shoshonean family to the Tonto Basin, included the Maricopas on the Gila River down to the Cocopa country, and thence again ran to the ocean.

Jesuit missionaries began working in the peninsula of California about 1697, but never met with cordial receptivity among the natives. At the southern extremity dwelt the Pericú Indians; they lived, says Venegas, from Cape San Lucas northward, beyond the harbor of La Paz; for Padre Miguel del Barco, who wrote in 1783, says that the Pericú tongue was spoken fifty leagues north of Cape San Lucas. They lived in small tribes, and the most noted of these were the Coras, once known as Edúes to the inhabitants of Loreto. Some writers classed them as Waikuru, and as the name Cora may be identical with kuru in Waikuru, it is quite possible that all or most of the Pericúes spoke Waikuru. Nothing of their language has reached us except the names of seven Pericú deities and a few local names (in Venegas, Gilij), all of which have a musical and vocalic sound.

Farther north, between 23° 30′ and 26° lat., lived, or still live, the Waikuru Indians in small scattering bands. The more important of their tribal bodies were, from the names of their dialects, Loretano, Cora, Uchitie, Aripe (Hervas). The Laimon, the 'gente del adentro,' spoke the dialect in use around the Loreto mission. About eighty words of their language have come to our knowledge, contained in the Lord's Prayer and church literature, which so far as they go show no affinity of decided character with the Yuman dialects spoken north of their settlements and on the mainland. The language is vocalic and sounds agreeably, but differs entirely in phonology, words, and grammar from Yuma, and has to be set down as a family by itself.

On the eastern side of the Gulf of California are settled a number of tribes with affinities heretofore subject to doubt, as the Guayma and Upanguayma, the Salineros, and the Cocomaques; also the Tepoka, who live opposite the large Island of Tiburon. They are grouped in the vicinity of the Seri, a wild and indomitable people who live partly in mainland Sonora and partly on their old home, Tiburon Island, frequently changing their abodes. At greater distances from the Seri dwell the Lower Pimas, the Pápagos, also the nearly extinct Ópatas.

From ancient reports we gather the notice that the Tepokas and Salineros speak Seri, from Orozco y Berra that Cocomaques speak Guayma or a dialect of it, and from Alphonse L. Pinart, who traveled there in 1879, that the Guayma then spoke a dialect of the Lower Pima.

The vocabulary of Seri obtained by A. L. Pinart shows many accumulations of consonants, some of them difficult for us to pronounce, and occurring mainly at the *end* of the vocables. In his collection the words seldom end in vowels, but in McGee's there are as many vowels as consonants in final sounds. Pinart found the utterance guttural, and compares it in this respect with the Santa Barbara or Chumashan dialects of the State of California. The guttural, lingual and labial articulation is prominent over the other classes of consonants.

As to the grammatic part of Seri speech, we record some prefixes and a number of suffixes in nouns and verbs, but since every collector writes them differently, we know little about their pronunciation and less still about their function. Suffixes of common occurrence are -em, -χ′o, -lχ, -ok (or -mok), -st, mostly appended to nouns. For the Cochimi, some inflections of the verb and other grammatic elements were transmitted, but for Seri and Waikuru these are absolutely wanting for the present, for all that we have is mere words. A close study of the compound words may ultimately disclose case-forms in the noun and personal inflection in the verb, but as we have no texts of Seri, it is doubtful that they will aid us much in bringing on a result. Mr. Hewitt has made a fair commencement in analyzing etymologically the numerals and other terms. 'Comparing the vocables is, therefore, the only means left to us at present to solve the question of affinity of Seri with the neighboring languages. The terms in which affinity with Yuman dialects is most probable, are:

Seri : avát, âv't—blood ; hwàt in Yavapai.
hámt, amt, ampte—earth, soil; amát in Cuchan.
ehe—tree, bush ; e—i in Cuchan.
apis—tobacco; ópi in Cocopa.
kakólx—large ; kaokó—o in Cochimi.
ax, ache, ahj—water ; aha in Yavapai, and frequent in North American languages as ax, áha, etc.

A few more correspondences of this sort, especially expressing parts of the human and animal bodies, are found, but they are too weak in numbers and quality to prove anything against the overwhelming number of terms that show absolute disparity in Yuman dialects compared with Seri. The terminals of Yuma are more typically vocalic than those of Seri.

The possibility of Seri being of the same kin as the Nahuatl dialects spoken around it in the State of Sonora, viz. the Pima, Pápago, and Ópata, has been carefully considered by the noted Americanist, Professor J. E. Buschmann, member Royal Prussian Academy of Sciences (1854). The result was that no radical affinity existed between the two groups.

At present the chances stand entirely against genealogical affinity of Seri with Yuma ; but a final verdict can be rendered only after expert linguists have examined that language on the spot and obtained a lexicon and ethnographic texts in a way that will prove absolutely correct in their phonetics. A. S. Gatschet.

*ON THE INFLECTION OF THE ANGLE OF THE JAW IN THE MARSUPIALIA.**

The posterior part of the jaw in the Marsupialia has been long recognized as peculiar in that the angle, instead of projecting vertically downwards, as is usually the case in the Mammalia, is bent abruptly inwards so as to produce a horizontal shelf, thus giving the jaw, when viewed from the outside, the appearance of lacking an angle entirely, its arcuate lower border passing directly into the articular condyle.

With the object of ascertaining the cause of this condition, the writer has examined various mammalian jaws and also dissections and serial sections through the heads of the common opossum (*Didelphys marsupialis*) and the pouch young of the wallaby (*Macropus* sp.).

The opossum shows the following anatomical relations. The whole outer surface of the inflected angle is occupied by the outer fasciculus of the masseteric muscle, the entire inner surface by the pterygoideus internus. Both of these muscles are powerfully developed, while the pterygoideus externus is much reduced. The latter muscle is attached above the inflected angle. The inflection introduces three peculiar features: It increases abundantly the insertion area of the masseter and pterygoideus internus ; It places the latter muscle in opposition to the lateral traction of the masseter on a weak symphysis ; it renders the line of traction of the pterygoideus internus vertical, so that with a reduction of the pterygoideus externus there is scarcely any provision for transverse muscular motion and so for a sectorial or a grinding action of the teeth. Of these peculiarities the last is probably the only one of primary significance. It contrasts strongly with the usual condition in placental types.

Sections through the head of the developing wallaby show the cavity of inflection to be occupied by Meckel's cartilage. This seems to indicate that the inflection has originated by the disappearance of bony elements on the inside of the jaw and by the reduction of Meckel's cartilage. *The inflected portion represents primarily not an angle, but a part of the lower border of the jaw.*

* Preliminary paper read before the American Association for the Advancement of Science, New York, June, 1900.

The inflection very early became fixed in the Marsupialia, as shown by the Jurassic forms *Spalacotherium*, *Phascolotherium*, and *Triconodon*. In the opossums (Didelphyidæ), which (excepting *Myrmecobius*) are the most primitive forms of to-day, the inflection exhibits a primary relation to the vertically acting non-sectorial teeth. The same may be said of the Dasyuridæ judging from *Dasyurus*. The thylacine, representing a predaceous carnivorous type, has not been available for examination. The kangaroos (Macropodidæ), which resemble the placental Ungulata, to a great extent, in tooth action and jaw structure, show no downward prolongation of the angle for the increase of the pterygoid insertion area such as is characteristic of the latter. The presence of the inflection makes it necessary to get the required increase in another way, and in such a manner as to substitute a transverse action of the muscle for a primitively vertical one. It is accomplished by a great excavation of the internal surface of the base of the inflected angle. In its interference with the downward prolongation of the angle, the inflection is detrimental; in other respects it is functional, since that part of the pterygoideus internus which is attached to its tip still acts vertically and also opposes the traction of the masseter on a weak symphysis. The phalangers (Phalangeridæ) take an intermediate position between the Didelphyidæ and the Macropodidæ. *Tarsipes*, which is unique in lacking the inflection, is degenerate in this respect, since it also lacks the coronoid process and has reduced teeth. The koala (*Phascolarctus*) shows a secondary straightening out of the angle associated with a deep auditory bulla. The wombats (Phascolomyidæ), and the bandicoots (Peramelidæ) show no points of special interest.

An examination of the available evidence leads to the following conclusions:

(1) The inflection of the angle is primarily associated with an exclusively vertical action of the teeth.

(2) It probably originated by a reduction of bony elements and of Meckel's cartilage on the inside of the jaw.

(3) The inflection became fixed in the Marsupialia, and is to be regarded throughout the existing series as a persistent primitive character.

(4) In primitive Marsupials, such as the Didelphyidæ, the inflection retains its original character, while in specialized types, such as the Macropodidæ, it becomes modified in an attempt to substitute a partly transverse muscular action for an exclusively vertical one.

(5) The inflection may be secondarily functional in many cases in opposing the traction of the pterygoideus internus to the lateral traction of the masseter on a weak symphysis.

B. ARTHUR BENSLEY.
COLUMBIA UNIVERSITY.

OKLAHOMA GEOLOGICAL SURVEY.

THE necessity for geological work in Oklahoma is the more obvious in view of the fact that the surveys of adjoining States have been in progress for a number of years. Kansas, Missouri, Arkansas and Texas have already published largely on this subject, while in Oklahoma nothing has been written except a few scattered articles.

During the past summer the initial work of the Survey has been accomplished. A sum sufficient to begin the work was appropriated by the last Legislature. Dr. A. H. Van Vleet, of the University of Oklahoma, had charge of the work and acted as zoologist for the Survey. Other members were C. N. Gould, geologist, Paul J. White, botanist, and Roy Hadsell, general assistant. The party traveled by wagon, being provided with tents and other necessary campiug facilities.

It had been planned to spend part of the season in the Wichita Mountains, but permission to enter the Kiowa reservation, in which the mountains are situated, not having been granted, the plan of the route was changed. From Norman, the seat of the university, the party went north to Perry and Stillwater, then west across the northern part of the Territory as far as Camp Supply, south to the Washita river, and east through Norman, across the Seminole and Creek reservations to Okmulgee, north past the Tulsa coalfields, through the Cherokee and Osage nations to the Kansas line and south again to Norman. In all about 1,500 miles were covered and every county in Oklahoma except three were visited.

Although the trip was of necessity little more than a reconnaissance, still the work as a whole was most satisfactory. The Red-beds—one of the most vexing of western geological groups—were studied throughout the Territory. Three large salt plains were visited; the ledge of gypsum which extends from Kansas to Texas was traced and mapped for several hundred miles; fossils were collected from five different localities representing as many horizons in the Red-beds. Numerous outcrops of *comanche* Cretaceous fossils were located in the western part of the Territory. Collections of considerable importance were made in the various formations, and the fossils are now being worked up in the Museum of the University. When these shall have been identified it is hoped that the question of the age of the Red-beds will be definitely settled. In the eastern part of the Territory the relation of the coal and oil fields of the Carboniferous to the Red-beds was investigated. Throughout the trip the question of water supply was given considerable attention.

Dr. Van Vleet made good collections of the animal life of the region, paying particular attention to snakes and birds. Mr. White's large collection of plants is of much interest in that it comprises several species that are probably new to science.

Mr. Hadsell devoted much time to collecting historical data, particularly that pertaining to Indians and old government trails and forts. About 150 photographs were taken illustrating the various phases of the work.

A report of the progress of the survey will be presented to the Governor before the meeting of the next Legislature. In addition, a number of short articles will be written setting forth the work in greater detail. It is confidently hoped that legislative appropriation will be sufficient to enable much more effective work in the future.

Charles Newton Gould.
The University of Oklahoma,
Sept. 18, 1900.

MOSQUITOES OF THE UNITED STATES.

For many years a few medical men have nursed the theory that mosquitoes may be carriers from man to man of the germs of human malaria. Quite recently physicians have produced evidence that makes this no longer a theory but a demonstrated fact. The result is that there is a great demand in all civilized countries for information regarding mosquitoes. This demand found the entomologists of the world illy prepared with definite facts about the lives and habits of the different kinds of mosquitoes. It was not until 1896 that any thoroughly satisfactory figure of a well-determined species of mosquitoes from the United States, or any account of its early stages, was to be found in the literature. Then Dr. L. O. Howard, U. S. Entomologist, published (Bull. 4, New Series, U. S. Div. of Entomology) a full and carefully illustrated account of *Culux pungens*, and also included a digest of his previous articles on remedies for mosquitoes and a tabulated statement regarding the different species in this country. Continuing the work so well begun, Dr. Howard made further important studies of mosquitoes, which he has embodied in Bulletin No. 25, New Series, U. S. Div. of Entomology, 70 pages, entitled 'Notes on the Mosquitoes of the United States, giving some account of their structure and biology, with remarks on remedies,' which was issued early in September. Some of these 'notes' are of a monographic nature.

Under the first heading, 'On mosquitoes in general,' are given interesting accounts of the excessive abundance in which mosquitoes have occurred in ancient and modern times, even in extreme northern latitudes. The length of life of the adult mosquito may vary from a few days in confinement to months when in hibernation; a brief general statement of the life-history of mosquitoes is given; in relation to the food of adult mosquitoes, it is stated that the male does not necessarily take nourishment, but they have been seen sipping at drops of water, molasses and beer, while one instance is given where they were made drunk with wine; the females are believed to be normally plant feeders, less than one in a million ever getting the opportunity to taste the blood of a warm-blooded animal. Evidence is submitted to show that mosquitoes do not fly far and also that they are not liable to be carried by strong winds, but railway trains are apparently important means of transporting unlimited quantities of them for unlimited distances. Many believe that mosquito larvæ can live for a considerable period in mud or dried up pools, but the evidence submitted indicates that when the mud dries up entirely the larvæ are necessarily killed. The world's mosquito fauna, as far as known, comprises about 250 species, of which only about 30 have been found in the United States, these representing 5 different genera.

Upon the very important and interesting topic of 'mosquitoes and malaria,' I think more should have been said in such a combined popular and scientific bulletin. A brief and popular abstract of Major Ross' intensely interesting article, only cited, would have been welcomed by many readers who, like myself, have not been able to follow closely the trend of recent scientific discovery in this all-important field. It is stated that there is now 'very perfect proof that mosquitoes may and do transfer the malaria germ from a malaria patient and deposit it in the blood of a healthy person'; only the mosquitoes of the genus *Anopheles* have been found to contain the human blood parasites, but apparently no other genera except *Culex* have been investigated, and our southern physicians are advised to study the very large mosquitoes of two genera occurring there from the malarial standpoint.

'Synoptic tables of the North American mosquitoes' are next given. I doubt if more suggestive scientific names occur in any other group of insects; for instance: *excitans*, *stimulans*, *pungens*, *perturbans*, *excrucians*, *provocans*, *impatiens*, *punctor*, and *damnosus*.

The bulletin is teeming with original observations and experiments, especially in relation to the biology of *Culex pungens* and *Anopheles quadrimaculatus* and remarks upon other species and their general distribution in the United States. Detailed accounts of the life-histories and habits of these two species are given and illustrated by remarkably accurate and instructive figures of all stages and many details of structure; no such thorough and excellent account of any of the species of mosquitoes, especially of the very important malaria-carrying genus *Anopheles*, has before found its way into the world's literature. Such painstaking work deserves the highest commendation and it is a pleasure to credit it to our worthy official entomologist at Washington. It is shown that the different stages and habits of *Anopheles* mosquitoes are quite different from those of the genus *Culex*, and the figures illustrating the differences are very instructive. *Anopheles* larvæ inhabit mostly 'fairly permanent stagnant pools of water uninhabited by fish, but more or less covered with green scum.' Many other important and interesting new facts recorded in this portion of the bulletin cannot be mentioned in this brief review.

The three other genera of mosquitoes, *Psorophora*, *Megarhinus* and *Aëdes*, found in the United States, are briefly discussed and the adult of one species in each genus is figured. The natural enemies of mosquitoes, such as dragon flies, water beetles larvæ, fish and birds, are succinctly discussed.

Nearly 16 pages of the bulletin are devoted to what is undoubtedly the best and fullest discussion of 'remedies against mosquitoes' in entomological literature. Dr. Howard's previous articles on the kerosene treatment of breeding places are condensed, and many suggestions from experience and from published records for preventing and alleviating mosquito bites are included. The effective methods of destroying the larvæ by the use of kerosene on the water, the proper drainage of the land, the practical use of fish, the agitation of the infested water are discussed in detail. Other unsuccessful experiments with larvicides, such as permanganate of potash and several proprietary mixtures are recorded. A most extensive series of experiments with culicidal mixtures made in Italy are briefly abstracted, and unsatisfactory experiments with tar and its compounds are given in detail. Some strong evidence is given to show that eucalyptus trees are valuable malarial deterrents. Still more evidence may be found in the writings of forestry experts who think that the planting of these trees in suitable regions may accomplish wonderful results in reducing malaria either by drainage of the soil or by modifying the water so as to render it uninhabitable for mosquitoes. While it is true that the planting of eucalyptus trees is not a sovereign remedy, as Dr. Nuttall points out, for malaria still prevails at Tre Fontane, outside of Rome, in spite of the planting of these trees, I am told by a forestry expert who has visited this place that before the plantings it was utterly uninhabitable, while now monks and workmen live there, and malaria is much reduced.

The bulletin closes with a strong plea for 'drainage and community work,' and striking instances are given where wonderful results have been attained.

In an appendix is given a translation of Meinert's brief, earlier account of the larva of *Anopheles*, and several paragraphs of a very important report of the Malarial Expedition of the Liverpool School of Tropical Medicine which was received too late to incorporate in the body of the bulletin. In this latter report are recorded many important observations on the bionomics of *Anopheles* larvæ and adults.

From a popular, biologic or scientific standpoint, this bulletin on mosquitoes is a very important, instructive, interesting and useful addition to the world's entomological literature.

M. V. Slingerland.
Cornell University.

SCIENTIFIC BOOKS.

The Norwegian North Polar Expedition, 1893–1896. Scientific Results. Edited hy Fridtjof Nansen. New York, Longmans, Green & Co. 1900. 4to. Pp. viii + 379, 46 plates.

In this sumptuous volume we have the first instalment of the scientific results of the celebrated North Polar expedition led by Dr. Nansen. The series is intended to contain a complete account of the scientific harvest of the expedition, and will doubtless form the standard work of reference for all scientific data of the North Polar basin for many years to come. This volume is printed in Christiania and issued at the cost of the Nansen fund for the advancement of science. Large and thick as the volume is, the excellent paper used makes it light enough to handle with ease, while the typography and illustration are first class.

The work opens with an introduction by the editor in which the services of those who made the expedition possible are given due appreciation and grateful acknowledgment made of the enthusiastic devotion of the members of the party to their often multifarious labors. The absence of a detailed chart of the movements of the expedition is explained by the fact that the computation of the astronomical data is not yet fully completed and it was undesirable to delay the publication of memoirs ready for the press. The chart therefore will appear in the second volume. The various memoirs will be printed as soon as ready, each separately paginated but carrying a serial number by which it may easily be referred to.

Five memoirs appear in the present volume. The first, by Colin Archer, gives a full description of the construction of the *Fram* with diagrams. This will be of permanent value to those contemplating future exploration of the icy regions. The soundness of the theories upon which the vessel's construction was based is sufficiently proved by the fact that, after all her battles with the ice and other experiences, a careful survey showed that with the exception of the bending of one of the metallic fenders of the rudder, she had sustained no injury whatever.

While Nansen was enjoying the hospitality of Jackson at Cape Flora, he obtained a collection of invertebrate fossils from a stratum of clay below the basalt of the cape. This collection is very fully discussed by Dr. J. F. Pompeckj who finds the fauna to be of upper Jurassic age. A few plant remains were obtained from deposits occurring in depressions on the upper surface of the basalts. These are reported on by Nathorst who finds them to be probably of the uppermost Jurassic epoch. From these facts the basalts would appear to be also Mesozoic, though hitherto they had been supposed to be Tertiary. Robert Collett and Nansen discuss the birds obtained by the expedition. Excluding those belonging to the fauna of the coast of Siberia, the bird life of the Polar Sea appears in this region to comprise but one land form, the snowbird (*Plectrophenax nivalis*), the rest being seafowl, gulls, auks, etc., of which thirty species were obtained. The rarest and most interesting of these is the rosy gull (*Rhodostethia rosea*). The ivory gull, the fulmar and the kittiwake were the most abundant. The food of the seafowl proved to be chiefly crustacea and small fish, obtained from cracks and water leads which occur in almost all the floes from time to time.

The last and most voluminous article is by Professor G. O. Sars, who describes the crustacea and illustrates them by a magnificent series of autotype plates which will call forth the admiration and gratitude of all carcinologists. Most of the crustacea are copepods, minute shrimps which serve as the chief food of the whale and seafowl. The westerly drift from the Siberian coast brings with it quantities of minute algæ and diatoms upon which the crustaceans subsist. They belong to the superficial stratum moved by the prevalent winds. Professor Sars, however, believes that the fauna of the deeper waters is derived from the Atlantic inflow below the superficial stratum. Among them it was a surprise to find, associated with strictly polar forms, several heretofore known only from the tropics, the Mediterranean and even the Caspian Sea. Very few marine animals except crustacea were found in the Polar basin. A tiny tomcod (*Gadus saida*) was the only fish observed in the high north.

The second volume will probably contain the astronomical, magnetic and pendulum observations, with charts and diagrams, discussed by Geelmuyden, Steen and Schiötz and may be expected to appear very soon.

W. H. DALL.

Biological Lectures from the Marine Biological Laboratory of Woods Holl. 1899. Boston, Ginn & Co. 1900. Pp. 282.

This annual, whose appearance is always awaited with interest, has enlarged its scope so that it no longer, as formerly, includes only lectures 'delivered at' Woods Holl, but contains in addition to such lectures essays written especially for the volume by persons not in attendance at the session, but in sympathy with the work of the laboratory. At present, then, the volume may be said to be representative of American biology. In its scope the volume is unique; its contents are addressed by naturalists to a general biological audience—an audience which demands at once that the author shall have something worth while to say and that he shall say it in an intelligible manner, free from the burden of a very special and technical nomenclature, while scientific rather than popular.

There are sixteen lectures in this volume, of which four are botanical. D. H. Campbell treats of the 'Evolution of the Sporophyte'; D. P. Penhallow of the 'Nature of the Evidence exhibited by Fossil Plants'; and D. T. MacDougal has two papers on the 'Influence of Vertical Air Currents upon Distribution' and on 'Mycorrhizas,' respectively. Then follow three papers of general psychological interest; two by Edward Thorndike on 'Instinct' and 'The Associative Processes in Animals,' based on his own illuminating investigations, and one by H. S. Jennings giving a resumé of his brilliant results on the 'Reactions of Unicellular Organisms.' C. H. Eigenmann contributes a paper on 'The Blind Fishes' and A. Hyatt, a 30-page paper on 'Some Governing Factors usually neglected in Biological Investigations,' which calls for an appreciation of meta-genetic (gerontic) stages in ontogeny, defends the 'law of tachygenesis or accelerated development' and argues for the memory theory of heredity. A. G. Mayer discusses the ontogenesis and phylogenetic significance of color in Lepidoptera. A. Mathews analyzes the different methods of animal secretions and combats the theory of special secretory nerves. T. H. Morgan discusses some old and new interpretations of regeneration. G. N. Calkins draws important general cytological conclusions from the varied forms of nuclear division in protozoa. C. M. Child after giving his researches on spiral cleavage concludes that it is the organism—the individual—which is the unit and not the cell. The reviewer writes of the aims of the quantitative study of variation and J. Loeb tells of his success in getting unfertilized eggs of sea urchins to develop into larvæ under the action of magnesium chloride. The mere enumeration of these subjects indicates that biological investigation in this country to-day occupies a broad field.

C. B. Davenport.

A Manual of Elementary Practical Physics. By Julius Hortvet, B.S. Minneapolis, H. W. Wilson. 1900.

During the last few years which have been signalized by the great extension of laboratory instruction in physics in the secondary schools of this country, so many new text-books of physics have been published that one can scarcely treat a new-comer without prejudice. These books must avoid a Scylla and Charybdis quite as dangerous as those which threatened Ulysses. On the one hand they fail by trying to be too general, applicable to too many cases, the school, the college and even the university; on the other hand they represent some particular, special course which their author has worked up, too often with some personal hobby for certain things. In this last class fall those courses which are designed as an entrance requirement for some college, and which are too much elementary mechanics and too little physics.

Mr. Hortvet has recognized that it is his duty to give his students the best possible course in general physics which they can utilize, without leaving it to a possible college course to give the real fundamentals. It is the business of the college to coordinate its work upon that of the high school, provided only that the high school is doing the right work and doing it well. Mr. Hortvet understands that his laboratories are neither kindergartens nor research laboratories.

Many teachers with the catch words of *intensive*, rather than *extensive*, fail to apprehend the real meaning of the terms, and are so extensive in their desire to be intensive that the scholar is lost in a mass of details and gets no fundamental principles. These teachers feel that they could not touch the subject of refraction of light without including anomalous dispersion and double refraction, and hence dawdle upon a mass of insignificant experiments in mechanics. This book is decidedly the best setting forth of the best collection of experiments for secondary school work which I have been able to obtain. From the contents it will be seen how well the choice of experiments in the various subjects has been made: General and mechanics, 14 heads; sound, 2; heat, 6; light, 7; and electricity and magnetism, 9. Or by pages: General and mechanics, 100; sound, 12; heat, 30; light, 32; electricity, 55.

The general instructions are very good and well presented. The line illustrations are thoroughly satisfactory; they have been made for this book and are not reproductions of hackneyed and inapplicable cuts from other texts. To be commended are also the outline tables and suggestions for making the records in the note book. In fact there is so little to find fault with in the book that the little may be ignored.

The book is its own evidence of the practical work the author has been doing in his schools and is at once a guide and a standard for other teachers. The book should be in every laboratory where physics is taught.

W. Hallock.

An Inquiry into the Conditions relating to the Water Supply of the City of New York. By the Merchants' Association of New York. Copyright by The Merchants' Association, 1900. Published by the Association at its office, New York Life Building, New York City. 1900. 8vo. Cloth. Pp. xxxix + 627.

This large and well-filled volume is perhaps the most important technical municipal document ever issued from our modern press, either public or private. It presents the results of very complete study of the problem of water supply to the City of New York, made by a committee of experts of national and international reputation, under the direction of the Merchants' Association of that city. It was conducted purely as a matter of patriotism and public spirit, especially for the purpose of securing a reliable and useful collection of facts and data with which to throw light upon the great municipal question raised by the famous Ramapo contract. It is important in itself as giving an enormous amount of essential information, and hardly less so as illustrating a degree of public spirit and an extent of intelligent research relating to scientific and technical questions such as, perhaps, was never before seen as the product of a patriotic spirit in municipal affairs. The Association expended $33,000 in the work, and its officers and aids gave their services; even the experts in law, engineering and other departments giving their services to the value of tens of thousands of dollars and conducting investigations of very great extent and of immense value without charge. The costs incurred were defrayed by individuals who voluntarily advanced the money, and only about one-third of the total had been received from subscriptions at the date of the publication of the reports. The public spirit of the average citizen of New York is as remarkable for its diminutiveness as is that of a few individuals for liberality and self-sacrifice.

Thirty-three men of distinction in their several professions constituted the General Committee, and such men as Messrs. Bannin and Deming, Professor Goodnow, and Mr. LeGendre were on the Executive Committee; Messrs. Clarke, Hering, North, Stauffer, Prout, Bowker, Towne, Dresser, Olcott and Haines constituted the Engineering Committee and Deming, Sterne, Hinrichs, Dr. Edson, Fowler, Albert Shaw, Schiff, Maltbie and Mayo-Smith that on Finance and Public Policy. The Counsel were Messrs Dill, Peckham, McCurdy and Conklin. Mr. James H. Fuertes was employed to report on 'Sources of Future Supply' and valuable reports were obtained from Mr. Rafter on the 'Adirondack Supply,' Mr. Croes on 'Past and Present Supply,' from Mr. Crowell on 'Auxiliary Salt Water Supply,' and from Mr. Ward on 'Pumping Stations and Water Distribution.' Mr. Coler, the Comptroller, gave the committee most valuable assistance. The engineering, legal and commercial lines of business were thus well represented, and it is doubtful if any private enterprise could have brought together such an array of professional talent or secured so complete and useful a study of the situation and its demands.

The gist of the matter is that New York

needs to begin immediately preparations for extension of its water-supply on an enormous scale, if it is to be permitted to grow and to remain a safe and wholesome place of residence and a great business center. This fact has been pointed out by authority frequently and for years past, but no action has been taken by the usually inefficient city government. The supply immediately available will be exhausted in 1903, at present rates of impairment of margin, and by 1910 if the best methods are at once adopted to reduce wastes to a minimum.

The region of the Housatonic cannot be relied upon, it being outside the jurisdiction of the State. The Hudson may be availed of by establishing pumping stations well up the river and securing any needed filtration and purification. A supply from the Adirondacks would cost ten per cent. more but would be pure, or might be made so.

The Ramapo 'job' is discussed. The contract was to compel the City of New York to pay *seventy* dollars a million gallons for water which is now, and can in any quantity later, be had for *thirty* and less. The contract was to continue in force for forty years, and the property then still to remain in the hands of the company. By 1937, were the city to do its own work, its whole system would be paid for, principal and interest. Under municipal ownership there would be a cash profit over the contract work up to 1945 of nearly *fifty millions of dollars.* Under the Ramapo contract there would be a net *loss* of sixty millions and the total difference in favor of the City of New York would be *over one hundred millions of dollars.*

What wonder that the Ramapo scheme was so urgently and insidiously promoted!

The conclusions of the Committee are that no contract should be made with the Ramapo or other private parties; that supply by contract should be opposed by citizens of New York, individually, collectively and in their corporate capacity, with the utmost energy of which they are capable and by every possible means; that the Legislature should give the city power, if further authority is needed, to provide itself with a full supply of pure water, by condemnation as far as required, and should protect the city against further assault by individuals, corporations or traitorous officials. Steps should be at once taken to check all wastes and to provide for a constant and large increase in the supply of wholesome water.

This report is exceptionally important and every citizen of city or State should secure the opportunity to read it from beginning to end. Every good citizen will be glad to give credit to the few intelligent, enterprising and liberal citizens who have here struck hands in the endeavor to protect this national metropolis from possible piracy in view of the proven stupidity and worse of many of its own officials and of other political leeches.

R. H. Thurston.

GENERAL.

Professor William B. Scott, of Princeton University, has in preparation an elaborate work in seven volumes entitled 'Reports on the Princeton Expedition to Patagonia in 1899.' The work, which it is estimated will cost over $25,000, will be published by Nägeli, in Germany, but arrangements have not yet been made with an American publisher. The edition will be limited to about 500 sets, and the cost of the seven volumes, which will be subdivided into separate books, will be about $100. It is expected that the volume on invertebrate fossils by Dr. Ortman will be published early next year. The subjects of the volumes and the authors are as follows:

Volume I.—'Botany,' principally by Professor George Macloskie, of the department of biology, of Princeton. The 'Contributions on the subject of Mosses,' by Professor Dusen, of Sweden.

Volume II.—'Recent Mammals,' by Dr. Merriman, of the Department of Agriculture in Washington.

Volume III.—'Birds,' by Professor William E. D. Scott, of Princeton.

Volume IV.—'Zoology of the other groups,' by Dr. Ortman, curator of invertebrate paleontology in Princeton, and Dr. Rankin, of the department of biology of the University.

Volume V.—'Invertebrate Fossils,' principally by Dr. Ortman.

Volumes VI. and VII.—'Vertebrate Fossils,' principally by Professor William B. Scott, of Princeton, with contributions by Mr. Hatcher.

The preliminary autumn announcements of

Messrs. D. Appleton & Company include a new edition of Herbert Spencer's 'First Principles' and 'Elementary Physics,' by C. Hanford Henderson, Ph.D. 'Physical Experiments,' a laboratory manual, by John F. Woodhull, Ph.D., and M. B. Van Arsdale. 'Animal Life,' a first book of zoology, by David Starr Jordan, M.S., M.D., Ph.D., LL.D., and Vernon L. Kellog, M.S. 'The Elementary Principles of Chemistry,' by Abram Van Eps Young, Ph.B. 'An Analytical Key to some of the Common Wild and Cultivated Species of Flowering Plants,' by John M. Coulter, A.M., Ph.D. 'A Text-Book of Geology,' by Albert Perry Brigham, A.M. 'Plant Studies,' an elementary botany, by John M. Coulter, A.M., Ph.D.

BOOKS RECEIVED.

Street Pavements and Paving Materials. GEORGE W. TILLSON. New York, John Wiley & Sons. London, Chapman & Hall, Limited. 1900. 8vo., xii + 532 pp.; 60 figures. $4.00.

Die partiellen Differential-Gleichungen. HEINRICH WEBER. Braunschweig, Friedr. Vieweg & Sohn. 1. Band. 4th ed. Pp. xvii + 506. M. 10.

Untersuchungen zur Blutgerinnung. ERNST SCHWALBE. Braunschweig, Friedr. Vieweg & Sohn. 1900. Pp. vi + 89. M. 2.50.

Verhandlungen der deutschen Zoologischen Gesellschaft. J. W. SPENGEL. Leipzig, Wilhelm Engelmann. 1900. Pp. 170. M. 6.

Chemie der Eiweisskörper. OTTO COHNHEIM. Braunschweig, Friedr. Vieweg & Sohn. 1900. Pp. x + 315.

Lehrbuch der Mechanik. ALEX. WERNICKE. Braunschweig, Friedr. Vieweg & Sohn. 1900. Vol. I., pp. xv + 314. Vol. II., pp. xi + 373.

Leçons de chemie physique; Relations entre les propriétés et la composition. J. H. VAN'T HOFF. Paris, A. Hermann. 1900. Part III. Pp. ii + 170.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for September opens with an account of 'Unusual Modes of Breeding and Development among Anura,' by Lilian V. Sampson, to which is appended a valuable bibliography of literature on the subject. 'The Intestine of Amia calva' is described by William A. Hilton, most of the paper being devoted to its microscopic structure. It would seem best not to use the term 'intestinal convolutions' where the folds of the lining only are meant since the phrase is in general use among zoologists to denote the folds of the entire intestine. Frank Russell presents some 'Studies in Cranial Variation' based on some two thousand skulls of aboriginal Americans. Part XIII. of 'Synopsis of North American Invertebrates,' by G. H. Parker is devoted to the Achnaria. It is to be presumed that this series when completed will be published in book form on account of its great value to the 'general zoologist' as well as the student. There are the customary numerous reviews.

The Plant World for September contains the following articles: 'The Harts-tongue in New York and Tennessee' by William R. Maxon, 'Some Local Common Names of Plants' by C. F. Saunders, 'The Twin-flower (*Linnæa borealis*) in Pennsylvania' by Thos. C. Porter, 'Naturalized Compositæ' by Frank Dobbin, an extensive list of 'Plant Names of the Southwestern United States' by Myrtle Zuck Hough and 'The Southwestern Limit of *Juniperus Sabina*' by E. J. Hill. In the supplement, under 'The Families of Flowering Plants,' Charles Louis Pollard treats of the orders Scitamineæ and Microspermæ.

THE first article in *Bird Lore* for October is on 'The Bower-birds of Australia' by A. J. Campbell, illustrated with some fine photographs of the bowers of these interesting birds. Captain Gabriel Reynaud gives the second and concluding part of his article on 'The Orientation of Birds' concluding that the power to return over long distances is due to the sense of direction located in the semi-circular canals. Mrs. Henry W. Nelson tells, with illustrations of 'A Pair of Killdeer' and Thos. H. Montgomery, Jr., describes 'The Bird Course at the Marine Biological Laboratory, Woods Holl, Mass., during the summer of 1900,' the main aim of the course being to present suggestions as to lines of work. In the section 'For Young Observers' Alick Wetmore gives an interesting sketch entitled 'My Experience with a Red-headed Woodpecker' and in the 'Notes' Caroline G. Soule relates an experiment tried by her of attaching a painted paper flower, containing a small bottle of syrup, on a trumpet vine, and finding that it was regularly visited by a humming-bird. The editor discusses the province of the Audubon Societies and there are reports from some of the Societies themselves.

The *Popular Science Monthly* for October, completing the 57th volume, opens with the presidential address of Sir William Turner before the British Association for the Advancement of Science, describing the development of biological science during the present century. Professor Frederick G. Novy's article on the 'Bubonic Plague' reviews especially its ravages in the past. There follow articles on 'Gasoline Automobiles,' by William Baxter, Jr., on 'Some Scientific Principles of Warfare,' by William J. Roe, on 'Modern Mongols,' by F. L. Oswald, on 'The Religious Beliefs of the Central Eskimo,' by Professor Franz Boas, and on 'Mental Energy,' by Edward Alkinson. The present instalment of 'Chapters on the Stars,' by Simon Newcomb, is devoted to variable stars and the parallaxes of the stars. The number contains the index to the current volume. A journal such as the *Popular Science Monthly* is essential for the development and recognition of science in America, and the contents of the first volume under its new management show that the *Monthly* has secured the cooperation of the leading American men of science.

The Mazamas, a mountaineering club of the Western States proposes to publish a quarterly magazine devoted to the mountains, forests and natural scenery of America, especially of the northwest. The subscription which is $1.00, may be sent to Mr. W. G. Steel, 407 Ross St., Portland, Ore.

DISCUSSION AND CORRESPONDENCE.

AN EMINENT AMERICAN MAN OF SCIENCE.

To the Editor of Science: In Science for August 17th and 31st (pp. 277, 346) are names suggested for inscription 'in the Hall of Fame of the New York University.' Those of naturalists are John James [not Adam] Audubon, Spencer F. Baird, Asa Gray, Isaac Lea, John Torrey, and, later, O. C. Marsh, E. D. Cope, James Hall, J. D. Dana, J. S. Newberry and Alexander Winchell. There is one naturalist at least as much entitled to such recognition as almost any one of the preceding—Thomas Say, once of Philadelphia. If it is intended to indicate the historical development of biology in America, Thomas Say should stand preeminent. He was by odds the most versatile and accomplished of the early American naturalists and has left his impress on the zoology of the country to a greater extent than any of his contemporaries or, in fact, if we measure the range of his studies, than any of his successors. He was fully abreast of the science of his times and to a greater extent than any English naturalist, except Leach. A large proportion, if not most, of the common species of several orders of invertebrate animals were first named and intelligibly described by him. Numerous of the most common land and fresh-water shells, crustaceans, worms, and insects were introduced into the system by him. He paid attention also to the mammals, birds and reptiles, leaving the fishes alone to his friend, C. A. Lesueur.

You ask: "Are any of the readers of this Journal prepared to suggest how many men of science should be included among the 100 most eminent Americans no longer living, and who they should be?" Whatever the number, Say should be accorded a place in the very first rank among zoologists. In my judgment Dana and Cope are the only ones whose rank is equally high. Not far behind are Joseph Leidy and William Stimpson (I suppose that Louis Agassiz has not been proposed because he was born and became eminent in another land.)

It may be of interest to learn that Say's name has been inscribed among those of illustrious Americans in the vestibule of the Library of Congress. The Hon. Bernard R. Green, superintendent of the Library building, did me the honor of consulting with me on the selection of men of science for such distinction, and I suggested to him the title of Say. His name was paired with Dana's near the entrance into the Librarian's office. I understand that he has been congratulated on the aptness of the selection.

Theo. Gill.

Washington, October 1, 1900.

NOTES ON INORGANIC CHEMISTRY.

A NEW mineral from copper mines near the Burra in South Australia is described in the *Journal* of the Chemical Society (London) by G. A. Goyder. It is called sulvanite and is a thiovanadate of copper, this being the first recorded instance of a sulfid mineral containing vanadium as one of its principal constituents. The formula of the new mineral seems to be $3Cu_2S$, V_2S_5 or $Cu_3{}'VS_4$, cuprous thiovanadate.

AN article by W. H. Hess on the origin of cave saltpeter is found in the *Journal of Geology*. Many of the caves in limestone regions of this country contain notable deposits of earth very rich in saltpeter. This is particularly true of the Mammoth Cave of Kentucky, where may still be seen the remains of the vats and wooden pipes used in the manufacture of saltpeter for gunpowder during the War of 1812. Indeed it is said that had it not been for this saltpeter and that from some other similar caves, this war could not have been successfully waged. During the Civil War much saltpeter was obtained from the Southern Caves. It has always been rather assumed that the origin of these saltpeter deposits is to be found in the guano from the bats, which swarm in immense numbers in parts of these caves. This, however, the author of this paper dissents from, holding that these deposits have come from evaporation of water which has percolated through the surface soil above, from which it has taken up the soil nitrates. Similar nitrate deposits are sometimes found under rock-ledges. The paper cites in proof of this position analyses of cave-earth, cave-bat guano, and of the water which drips from above into the Mammoth Cave.

SINCE the hypochlorites are formed by the electrolysis of solution of chlorids, efforts have been made to utilize the reaction in technical chemistry. A study of this character is reported in a recent *Comptes Rendus* by André Brochet. He finds that in concentrated solutions in its later stages, the electrolysis of hypochlorites resembles that of the chlorids, tending toward the same limits. It would therefore follow that the preparation of concentrated solutions of hypochlorites from the chlorids can hardly be hoped for by direct electrolysis.

WE copy from *Nature* the prizes offered in chemistry by the *Société d'Encouragement pour l'Industrie Nationale* for 1901. 1,000 francs for the utilization of any waste product; 2,000 francs for a publication useful to chemical or metallurgical industry; two prizes of 500 francs each for scientific researches, the results of which can be utilized in industrial work; 2,000 francs for an improvement in the manufacture of chlorin; 1,000 francs for the discovery of a new alloy useful in the arts; 2,000 francs for a study of expansion, elasticity and tenacity of pottery clays and glazes, for a scientific study of the physical and mechanical properties of glass, for a new method of manufacturing fuming sulfuric acid and sulfur trioxid, and for the manufacture of a steel possessing specially useful properties by the introduction of a foreign element. Competition is open to all, but the memoirs, which must be sent in before December 31st, must be written in French.

J. L. H.

MUSEUM AND ZOOLOGICAL NOTES.

THE brief *Report of the Director* of the Manchester Museum for 1899–1900 shows the steady progress of this active Museum, which has recently acquired the Schill collection of butterflies and moths and the Layard collection of weapons and other implements from the Pacific islands. The experiment has been tried of opening the Museum on the first Wednesday of each month, and on this occasion having certain portions of the collections explained by some member of the staff. The result has hardly met with the success it merits, since the attendance has been small, particularly so when it is remembered that Manchester has a population of over half a million. The latest publication of the Museum is 'Notes on some Jurassic Plants in the Manchester Museum,' by A. C. Seward.

THE *Annual Report of the Director* of the Carnegie Museum, Pittsburgh, has recently been issued and shows a decided specialization in the line of fossil vertebrates, one-third of the Museum staff being accredited to the Department of Paleontology, Mr. J. B. Hatcher being the curator. The collections made in 1899 have already been noticed in SCIENCE, and equally good results may be expected from the work of the field party sent out early this year. The number of visitors during the current year is estimated at 350,000. Special effort has been made to put the Museum in touch with the public schools by issuing loan collections and by the 'Prize Essay Contest.' In the separate report on this it is interesting to note that the subjects most frequently chosen were those objects that appealed most strikingly to the eye. While this is only natural, yet it calls attention to the fact that while a museum may be a collection of labels illustrated by specimens, there is considerable danger that the label will be overlooked by the average visitor unless there is something about the object itself, or the manner in which it is shown, to attract attention.

SOMETHING of glamor hangs over the white cattle of Chillingham and Cadzon; they have been sung by poets and engraved by Bewick, the Chillingham herd has literally been within one of extinction and finally some authorities have considered these cattle as direct descendants of the vanished Urus. The last writer to discuss them is R. Hedger Wallace, who has undertaken an exhaustive inquiry into their origin and history, whose results are published in the *Transactions of the Natural History Society of Glasgow*. While Mr. Wallace explicitly states that his paper must not be considered as final, he yet states as his opinion that the white cattle are simply the descendants of Roman cattle imported into England during the Roman occupation. An extensive, though confessedly incomplete, bibliography of works and articles relating to the 'Bovidæ,' wild and domesticated, living and extinct, is appended.

F. A. L.

BOTANICAL NOTES.

THE BIG TREES OF CALIFORNIA.

NOT long ago the staff of the Division of Forestry of the United States Department of Agriculture prepared a most valuable and suggestive report on the big trees of California, which was issued as a Senate document, and afterwards published as a separate paper by the Department. The purpose of the report is to call attention to the groves of these great trees, and to enlist sufficient interest in them to secure their preservation. Their fine wood has tempted the lumberman, and in spite of their unwieldy size they are felled and split and sawed into lumber to such an extent as to threaten the utter destruction of many of the groves.

There are ten main groups of groves of the big trees scattered along the west side of the Sierra Nevada range, 'from the middle fork of the American River to the head of Deer Creek, a distance of two hundred and sixty miles.' Probably not more than five hundred trees in these groups are remarkable for their size.

The only grove thus far safe from destruction is the Mariposa, while 'the finest of all, the Calaveras Grove, with the biggest and tallest trees' has recently (April, 1900) come into the possession of a lumberman who quite certainly intends to cut the trees into lumber.

The report should be read by every lover of trees, and every effort should be made to have Congress take steps to preserve several of the finest of these groves. The excellent half-tone plates from photographs add interest and value to the paper.

THE AGE OF THE BIG TREES OF CALIFORNIA.

IN the report issued by the Division of Forestry in the United States Department of Agriculture referred to above, a discussion is made of the age of the Big Trees. The conclusion is reached that their age runs far up into the thousands, the great age of five thousand years being mentioned, apparently with approval. The writer of this note once counted with much care the rings of growth of a tree which was felled in 1853, and whose stump constitutes the floor of the so-called dancing pavilion. This count was made from circumference to center, and every ring in all that distance was *counted*, no 'estimates' or guesses being made. The result was that eleven hundred and forty-seven (1,147) rings were counted, and accordingly it is safe to say that this tree, which was fully twenty-four or twenty-five feet in diameter, and considerably more than three hundred feet in height, acquired these dimensions in eleven hundred and forty-seven years. The writer entertains grave doubts whether any of the existing trees approach the age of two thousand years.

LOCAL DESCRIPTIVE FLORAS.

IT is a good sign of the progress of systematic botany in North America that there is an increase in the number of floras of restricted regions in preparation by local botanists. Of course the authors of such floras usually succeed in adding something to the burden of botanical synonymy, but this is more than balanced by the additions made to our knowledge of the particular distribution of the species, and the geographical variations which some of them show. The 'Flora of Northwest America,' by Thomas Howell, and the 'Manual of the Flowering Plants of Iowa,' by T. J. Fitzpatrick, now publishing in parts, are good illustrations of systematic work. Of the former three parts, and of the latter two parts have appeared.

Mr. Howell's publication is more radical in its treatment of species, many being recognized as distinct which are usually not separated by botanists. In his preface he says: "Believing that if a plant has one constant character that is different from any of its congeners it is sufficient for a species; and if that plant is sufficiently distinct from others to deserve a name it is better to have it described as a distinct species than as a variety of some other species. I have, therefore, raised nearly all published varieties of the region embraced in this work to specific rank."

Mr. Fitzpatrick is more conservative, and follows more closely the common usage in this regard. In one particular he is quite abreast of the most radical of botanical writers, namely, in decapitalizing all specific names, and the omission of the comma before the authority.

In both books the descriptions are well drawn, and good keys serve to guide the student. One or two more parts of each should finish these useful books.

THE MRS. CURTISS MEMORIAL.

MANY botanists remember with pleasure the dainty specimens of marine algæ collected by Mrs. Floretta A. Curtiss, for many years a resident of Jacksonville, Florida. Year after year the little fascicles of exquisitely prepared specimens were offered to those who were interested in algæ, and who wished them for their herbaria. On March 3, 1899, she died in the seventy-seventh year of her life. Her son, A. H. Curtiss, the well-known botanical collector, has prepared a memorial, including a biographical sketch, and an index to her collections of algæ. This is in the form of a twenty-page folio pamphlet printed on heavy paper and illustrated with half-tone reproductions of photographs of the places where she lived while in pursuit of her favorite plants.

Mrs. Curtiss was born in 1822, in what was then the wilderness of central New York, not far from the present city of Syracuse. She came from New England stock, both parents being natives of Massachusetts. Immediately after the Civil War she removed with her husband to Virginia, and in 1875 with her son she took up her residence in Florida. Here she soon began the work of collecting algæ,—which she continued to the close of her life. Science owes her a debt of gratitude for the years of painstaking labor which she gave to the gathering and preservation of specimens, which have enriched the botanical collections of the World's great herbaria.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE AMERICAN PUBLIC HEALTH ASSOCIATION.

THIS Association will meet at Indianapolis from October 22d to 26th, under the presidency of Dr. Peter H. Bryce. There is a special section of bacteriology and chemistry, of which Professor Theobald Smith is Chairman. The subjects on which special committees have been appointed to make reports are:

1. 'The Pollution of Public Water Supplies'; 2. 'The Disposal of Refuse Material'; 3. Animal Diseases and Animal Food'; 4. 'Car Sanitation'; 5. 'Etiology of Yellow Fever'; 6. 'Steamship and Steamboat Sanitation'; 7. 'Relation of Forestry to the Public Health'; 8. 'Demography and Statistics in their Sanitary Relation'; 9. 'Cause and Prevention of Infectious Diseases'; 10. Public Health Legislation'; 11. The Duration of Infectious Diseases'; 12. 'Cause and Prevention of Infant Mortality'; 13. 'Disinfectants'; 14. 'Municipal Sanitary Adminis-

tration'; 15. 'To Define what Constitutes an Epidemic'; 16. 'On National Leper Home'; 17. 'Dangers to the Public Health from Illuminating and Fuel Gas'; 18. 'Revision of Bertillon Classification of Causes of Death'; 19. 'Transportation of Diseased Tissue by Mail'; 20. 'The Teaching of Hygiene and Granting of Degrees of Doctor of Public Health.'

It has been arranged to devote one day, Wednesday, October 24th, to the discussion of topics relating to sewerage and water supply. Special attention will be given to the engineering phase of this subject. The following subjects will be presented for discussion:

1. 'What Constitutes a Satisfactory Water Supply?' 2. 'The Value of Vital Statistics as an Index to the Pollution of Water Supplies'; 3. 'Comparative Statistics of the Water Supplies of the Leading American Cities as shown by Typhoid Fever Statistics'; 4. Conservation and Control of Water Supplies by State, Provincial and Municipal Authorities'; 5. 'The Relation of the Analytical Laboratory to Problems in the Pollution of Public Water Supplies'; 6. 'The Legal Aspect of Water Pollution'; 7. 'The Present Status of Methods of Purification of Sewage entering Public Water Supplies'; 8. 'Sewage Purification Plants now in Operation in America, with reference to Public Water Supplies'; 9. Methods of Purification of Water Supplies, with a Summary of Plants now in Operation in America'; 10. Recent Progress in Europe concerning the Purification of Water Supplies.'

SECTION ON BACTERIOLOGY AND CHEMISTRY.

1. 'On Standard Methods of Water Analysis'; 2. 'Laboratory Work on Tuberculosis'; 3. 'On Obtaining Experimental and Clinical Data on the Exact Mode of Infection in Rare and Unusual Cases'; 4. 'Study of the Causation of Cancer'; 5. 'Bacteriology of Milk in its Sanitary Relations'; 6. 'Variations of the Colon Bacillus in Relation to Public Health'; 7. 'Variations of the Diphtheria Bacillus'; 8. 'Bacteriology of Yellow Fever'; 9. 'Inter-Laboratory System of Card Cataloguing for Sanitary Bibliography'; 10. 'Use of Chemical Preservatives in Foods'; 11. 'Exhibition of Laboratory Apparatus and Appliances for Teaching Hygiene'; 12. 'Census of Laboratory Men engaged in Sanitary Work.'

SCIENTIFIC NOTES AND NEWS.

PROFESSOR GEORGE F. BARKER, LL.D., for twenty-eight years professor of physics in the University of Pennsylvania, has resigned his chair because of poor health. The corporation of the University has made him professor emeritus of physics and voted him a pension.

DR. N. F. DRAKE, of the Imperial Tien-Tsin University, whose explorations of the anthracite coal fields of China we recently noted, remained in Tien-Tsin during the late fighting in that city. German troops were finally stationed in the university buildings and completely destroyed the apparatus of the chemical and assay laboratories under Professor Drake's charge.

GENERAL A. W. GREELY, Chief of the Army Signal Service, has returned from Alaska. He was on board the steamer *Orizaba* which went aground at St. Michael, while laying a cable between that place and Nome.

PROFESSOR H. A. ROWLAND, of the Johns Hopkins University, was given at the Paris Exposition, in addition to the grand prize for his spectroscopic apparatus, which we have already noted, a second grand prize for his multiplex telegraph printing machine.

DR. E. W. SCRIPTURE, of Yale University, was awarded the gold medal of the Paris Exposition for methods of testing color-blindness.

PRESIDENT DANIEL C. GILMAN, of the Johns Hopkins University, who was granted a leave of absence last spring by the trustees, in commemoration of the twenty-fifth anniversary of his election, and has since been abroad, has returned to Baltimore.

THE College of Physicians of Philadelphia has awarded its Alvarenga prize for 1900 to Dr. David De Beck of Cincinnati for his essay entitled 'Malarial Diseases of the Eye.' Essays in competition for the prize next year must be received not later than May 1, 1901. The value of the prize is about $180.

THE daily papers report that the Mexican Government is considering the award of $100,000 to Dr. Angel Bellinzaghi, who was born in Italy in 1865, for his serum against yellow fever which is said to have proved successful in eighty-five per cent. of the cases in Mexican hospitals.

MR. JOHN E. HUDSON, president of the American Bell Telephone Company, died on October 1st. Under his management the company grew in ten years from a system of 739 exchanges and 411,861 instruments to one of 1,239 exchanges and 1,847,000 instruments with over a million miles of wire in service. Mr. Hudson was a man of wide scientific and literary culture, having been tutor in Greek at Harvard University.

The death is announced of Miss Margaret Stokes a distinguished Irish archeologist and the author of numerous antiquarian works.

Professor George Frederick Wright and his son, Fred. B. Wright, were in the midst of the troubles in China, and scientific men will be glad to learn that they have so far escaped unharmed. On May 5th they started on a three weeks' trip from Peking to Kalgan. That brought them back to Peking just as the Boxer movement culminated; but they left the city, in pursuance of regular plans one day before the gates were closed, and were in Tien-Tsin from the 26th to the 30th. On June 5th they had reached Port Arthur, and on the 6th took one of the construction trains of the Chinese Eastern Railroad. By train and Chinese cart they made their way to Harbin, Manchuria; and then down the Sungaree and Amoor rivers to Vladivostok. On July 10th they left Vladivostok, expecting to make good time to Chita if the boat did not stick on some sand bar in the river. At Poyakova, East Siberia, however, they had to exchange boat for tarantass and horses. After an exciting ride through deserted and burning villages they reached Blagovyeschensk at the middle of July to find it in a state of siege. On the 25th of July they were able to take passage on the return trip of a steamer that had come down to within twenty miles of Blagovyeschensk. With many delays on account of shallow water, they made their way up the Amoor and Shilka rivers to Stretinsk. At that point the Siberian railroad was taken to Chita and on to Lake Baikal. There a small steamer transferred them to the western side of the lake, where they again took train to Irkoutsk. The next stop was at Krasnoyarsk, on the Yenisei River. An interesting trip was taken up the river to Minusinsk, where there is a large museum of historical and archeological interest. Returning to Krasnoyarsk they continued their railroad journey to Omsk, at which point they were heard from September 6th. Their plans for the future were to go by boat up the Irtish river to Semipalatinsk, where they will have a chance to visit the foot of the Alti Mountains. Then they will go by tarantass and horses to Tashkend, where they will strike the Trans-Caspian railroad, which runs through Samarkand and Merv to the Caspian Sea. Baku and Trebizond will be the next stopping places. After a visit to Moscow and St. Petersburg, they expect to return to Constantinople and continue their trip through Palestine and Egypt, reaching home by way of Italy, in March.

The steamship *Windward* has not returned as had been expected, and it is suggested that Lieutenant Peary may have used the boat to push farther north as the season is supposed to have been an open one.

Lieutenant Amdrup's Greenland expedition has returned on board the *Antarctic*. The members of the expedition explored and mapped a hitherto unknown stretch of land extending from Cape Town, latitude 69 degrees 28 minutes north, to Agasis Land, 67 degrees 22 minutes north.

Messrs. C. H. Tyler Townsend and Charles Melvin Barbar made between the last of May and the first of November, 1899, extensive collections of plants on the Sierra Madres, in the State of Chihuahua, just east of the little Mormon town of Colonia Garciá, at altitudes varying from 7,000 to about 8,500 feet above the sea level. About 40 numbers were collected in the 'hot country' some distance down the Pacific slope of the range, and a few on the plains east of the mountains. An attempt was made to collect thirty sets, but the material will not run evenly through that many. 452 numbers in all were taken. The material is well dried and altogether very fair, and is supplied with printed labels. Something over 250 numbers have been identified at the present time, of which Professor E. L. Greene has named the *Compositæ*, *Mimuli* and *Loti;* Dr. J. N. Rose, the *Umbelliferæ* and *Commelinaceæ;* Dr. B. L. Robinson, the *Cruciferæ* and *Caryophyllaceæ;* Mr. E. P. Bicknell, the *Iridaceæ;* Dr. P. A. Rydberg, the *Potentillæ* and other *Rosaceæ* and some *Leguminosæ;* Dr. C. F. Millspaugh, the *Euphorbiaceæ;* Mr. R. A. Rolfe, the *Orchidaceæ.* Of this number Professor Greene has named 8 new species, Dr. Robinson 4, Dr. Rose 3, Mr. Bicknell 2, and Dr. Rydberg has indicated two new species of *Potentilla*, which he has not had time as yet to describe.

The second season of the Beaufort Laboratory of the U. S. Fish Commission came to an end on September 15th. The occupants of tables were from Johns Hopkins University, Columbia University, University of North Carolina and Trinity College (N. C.). The economic work, carried on by special assistants in the service of the Commission, embraced a study of the neighboring natural and artificial oyster beds, breeding times and food of certain food-fishes, life histories of fish (blennies), life history of a lepadide barnacle (Dichelaspis) which has been found to be a common parasite in the gill chambers of the edible crabs, Callinectes and Menippe. The more purely scientific investigations covered a wide field, embracing such diverse subjects as the systematic zoology and ecology of actinians, echinoderms, and sponges; embryology of ophiurans; larval development of actinians; regeneration phenomena in ophiurans, and in Renilla; embryology of gephyrean worms (Thalassema); cell lineage of Axiothea; experimental work on the cleavage of the oyster egg; cytological phenomena in the 'chemically fertilized' eggs of Toxopneustes.

The experiment made by English scientific men on mosquitoes and malaria to which we have called attention appears to have been successful. Drs. Sambon and Low and their associates, who have been living in a mosquito-proof hut in the Roman campagna drinking the water, exposed to the night air and taking no quinine, have so far been entirely free from malaria. On the other hand Dr. Manson's son, P. Thurburn Manson, who was bitten every second day by infected mosquitoes, fed in Rome on those suffering from malarial fever, suffered an attack of fever and tertian parasites were found in his blood.

The Pacific Commerical Museum, modeled after the similar institution at Philadelphia, has completed its organization by electing Irving M. Scott, president, Eugene Goodwin, secretary, and Isaac Upham, treasurer. It is amply provided with funds and will soon begin the collection of the products of the Pacific Coast, which are to form a permanent exposition in San Francisco.

The United States Civil Service Commission invites attention to the announcement which was made on September 12, 1900, of an examination to be held on October 23–24, 1900, for the position of assistant in the Nautical Almanac Office, and desires to state that as the result of this examination it is expected that certification will also be made to the position of computer in the United States Naval Observatory at a salary of $1,200 per annum, and for similar vacancies as they shall occur; certification being made, however, of those eligibles who have furnished evidence to the Commission that they have had experience in the use of astronomical instruments.

A course of lectures on science and travel is now being given in the Field Columbian Museum, Chicago, at three o'clock on Saturday afternoon as follows:

Oct. 6—'How Plants Live,' by Professor Charles R. Barnes, University of Chicago.

Oct. 13—'Do Invertebrates have Consciousness? by Dr. H. V. Neal, Knox College, Galesburg, Ill.

Oct. 20—'Wyandotte and Marengo Caves,' by Professor O. C. Farrington, Curator, Department of Geology, Field Columbian Museum.

Oct. 27—'The Life and Death of a Tree,' by Dr. Thomas H. MacBride, State University of Iowa.

Nov. 3—'Porto Rico and its People,' by Dr. Barton Warren Evermann, Ichthyologist of the United States Fish Commission.

Nov. 10—'Mining in the Ozarks,' by Professor Henry W. Nichols, Assistant Curator, Department of Geology, Field Columbian Musuem.

Nov. 17—'Variation of Organisms,' by Dr. C. B. Davenport, University of Chicago.

Nov. 24—'Picturesque Mexico,' by Mr. P. V. Collins, Minneapolis, Minn.

We learn from medical exchanges that Dr. Frances Dickinson, president of the Illinois Educational League, is making an effort to secure from the State Legislature an appropriation of $50,000 to be used in establishing in Chicago and in other cities State laboratories for the teaching of the sciences of physics, chemistry, bacteriology, biology and microscopy, and for extension courses throughout the State in sanitary and agricultural sciences. It is intended that the laboratories shall be open in the evenings to enable bread-winners to procure a higher education than they are able to get now.

IT is reported that, upon the recommendation of the Department of War the Department of Agriculture is preparing an order setting apart as forest reserves the island of Rombolin, north of the island of Panay; also the island of Pauitaui, which is one of the extreme group of the Jolo Islands. Officers of the army who have been looking over the islands have found that these are perhaps the richest islands in the world for rubber trees, and it is the intention of the Washington authorities to have the trees preserved and cared for, especially as some fears lately have been expressed that the rubber supply may become exhausted.

THE International Railway Congress, held this year at Paris, will meet in 1901, at Washington, D.C. At the Paris meeting M. Bandin, French Minister of Public Works, paid a high tribute to the advanced state of railway construction and management in the United States, saying that all the later improvements adopted in Europe came from America. European countries, he said, ought to realize that in railway improvements they are behind the United States and should take constant lessons from its methods.

IT is somewhat remarkable that while there are about 18,000 miles of electric trolley lines in the United States there are only about 300 miles in Great Britain and Ireland. It might be supposed that the more dense population of the British Isles would especially support such lines. Recent financial conditions indicate that if an extension of the trolley lines in Great Britain is not soon undertaken by citizens of that country the field will be occupied by American engineers and capitalists.

A NEW transatlantic liner of unequalled dimensions is to be built by Kewland & Wolff, of Belfast, Ireland, for the Hamburg-American line. According to the press dispatches the new ship will be 750 feet long and 76 feet beam and will have accommodations for 2,000 passengers and 12,000 tons of cargo. The speed will be 18 knots, and the most improved construction will be used throughout. The main dimensions of the *Oceanic*, at present the largest vessel, are: length 704 feet and beam 68 feet 4½ inches. The new Hamburg-American ship is to be completed in 1903.

THE International Congress of Applied Chemistry was held in Paris during the last week of July, under the presidency of M. Moissan. There were as we have already stated ten sections: analytical chemistry, chemical industry of inorganic products, metallurgy, mines and explosives, chemical industry of organic products, the sugar industry, chemical industry of fermentation, agricultural chemistry, hygiene, food analysis, medical and pharmaceutical chemistry, photography and electrochemisty. *Nature* reports that more than two hundred papers were read and discussed, and numerous resolutions were passed, of which the following were the most important. In view of the great inconvenience caused commercially by uncertainty in the atomic weights used by analytical chemists, the congress, hoping that the adoption of the atomic weight of oxygen as a base ($O = 16$) would lead to a greater certainty and to a simplification in the calculation of atomic weights, agreed to work in unison with the International Commission on atomic weights. It further suggested the necessity for an International Commission for fixing methods and cœfficients of analysis in commercial work. Committees were also appointed to deal with questions of indicators in volumetric work, analysis of manures, potash estimation, and the use of sulphurous acid in wine. In the second section the chief questions dealt with were the determination of high temperatures, construction of glass and porcelain furnaces, the manufacture of sulphuric acid, and of barium and hydrogen peroxides. In the section of metallurgy, mines and explosives, papers were read dealing with the sampling of minerals, the constitution of iron and steel, the use of the microscope in the study of metals, utilization of waste heat, and the estimation of sulphur, manganese and phosphorus in metals. In the section dealing with the industry of organic substances the most important discussion was on the use of alcohol for other than drinking purposes, and a series of resolutions was passed stating that in the opinion of the congress no duty should be charged upon alcohol used in the preparation of pharmaceutical and chemical products. In the case of alcohol intended for use as fuel, the substances added should be of a character appropriate to its use, not too costly, and not containing any non-volatile substance. Any attempt to recover pure alcohol from methylated spirit should be liable to severe penalties, and all makers of stills should be compelled to give particulars to the excise authorities of stills sold or repaired. In the other sections discussions were held on the relation of the sugar industry to the State, the methods of analysis of wines and spirits, the carbide industry, manufacture of percarbonates, and numerous other papers of interest.

UNIVERSITY AND EDUCATIONAL NEWS.

The new observatory of Wellesley College, the gift of a member of the Board of Trustees, was formally opened October 8th. Addresses were announced by Professors E. C. Pickering and David P. Todd.

Union College has received $10,000 from members of the Mather family of Jefferson county for the establishment of a department of agriculture.

Francis T. White, of New York City, has given $25,000 to Earlham College, a Friends' institution in Indiana, to be added to the like amount given by him a year ago, the whole to be known as the Francis T. White endowment fund.

The Faculty of Jefferson Medical College, Philadelphia, have recommended the establishment of a J. M. Da Costa Memorial Laboratory of Clinical Medicine in memory of the late Dr. Da Costa who was a graduate of the institution and left to it his collections.

The new School of Commerce, Accounts and Finance of the New York University was formally opened on October 2d, by Chancellor McCracken. Professor C. W. Haskins is the dean of the new school which started with an enrollment of about fifty students.

The Cornell Medical School now occupies its new building on First Avenue between Twenty-seventh and Twenty-eighth streets, New York City.

The University of Illinois has in course of construction a new agricultural building which will probably be the most extensive building in the United States devoted to agricultural education. $150,000 have been devoted to its construction.

President Charles Kendall Adams, of the University of Wisconsin, has been give leave of absence owing to ill-health and will spend a year or more abroad. Dr. E. A. Birge, professor of zoology, and dean of the College of Letters and Science has been made acting president.

Dr. George H. Ashley, formerly assistant State Geologist of Indiana, has accepted the professorship of natural history at the College of Charleston in South Carolina. This is the position once held by Alexander Agassiz.

Dr. T. Bird Moyer, Ph.D. (Univ. of Pa.), instructor in chemistry in the University of Pennsylvania, has been recently elected to the professorship of chemistry in the Pennsylvania College of Dental Surgery.

Arthur L. Clark has been appointed professor of physics in Bates College, succeeding Professor M. C. Leonard who is now teaching in Japan.

The following assistants have been appointed in Columbia University: Alfred Tringle, Ph.D., analytical chemistry; Frank E. Pendleton, Ph.D., mechanical engineering; Llewellyn Le Count, civil engineering; Chas. H. Hitchcock, mining; Wm. G. Clark, metallurgy.

At Johns Hopkins University, D. N. Shoemaker has been appointed assistant in zoology and Dr. Gordon Wilson fellow in pathology.

SCIENCE

FRIDAY, OCTOBER 19, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson N. Y.

PROCEEDINGS OF THE SECTION OF BOTANY AT THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION.

VICE-PRESIDENT TRELEASE'S address on 'Some Twentieth Century Problems' was given in the large botanic laboratory in Schermerhorn Hall, on Monday, June 25th, at 3 p. m. (Published in SCIENCE, 12: 48, 1900.) On the following day and on the 29th, regular sessions were held for the reading of papers after the customary manner, and a list with some abstracts is given below.

The Torrey Botanical Club gave, by invitation, a special memorial program in honor of Dr. John Torrey, in the Museum of the New York Botanical Garden, on Wednesday, June 27th. The principal features of the day were:

'Reminiscences of Dr. Torrey': DR. T. C. PORTER.

'Work of Dr. Torrey as a botanist': DR. N. L BRITTON.

'Historical sketch of the development of botany in New York City': DR. T. F. ALLEN.

'Comment on the earlier botanical history of New York': JUDGE ADDISON BROWN.

'Work of the Torrey Botanical Club': SECRETARY E. S. BURGESS.

Comments and reminiscences: PROFESSOR PECK, PROFESSOR MACLOSKIE, PROFESSOR BEAL and DR. T. F. ALLEN. A communication from JAS. HYATT was also read. These papers will be published in the *Bulletin of the Torrey Botanical Club.*

The sectional committee had concluded arrangements with the Council of the Botanical Society of America by which the program of the latter occupied the sessions on Thursday. A symposium on the plant geography of North America had been arranged for Friday, June 29th, in which the following papers were read:

'Distribution of the Spermatophytes in New England': B. L. Robinson.

'Distribution of the Spermatophyta in Southeastern United States': J. K. Small.

'Notes on the Lower Austral Element in the Flora of the southern Appalachian region': Thos. Kearney.

'Physiographic Ecology of Northern Michigan': H. C. Cowles.

'Vegetative Elements of the Sandhill region': Roscoe Pound.

'Composition of the Rocky Mountain Flora': Per Axel Rydberg.

'Flora of the Colnmbian Lavas': C. V. Piper.

'Distribution of the Grasses of North America': G. V. Nash.

'Relationship between the North and South American Floras': W. L. Bray.

'Floral Zones of Mexico': J. N. Rose.

'Origin of the flora of North America': N. L. Britton.

The committee on bibliography reported that the publication of the card catalogue of literature relating to American Botany had been undertaken by the Torrey Botanical Club.

The Bacterial Air-Flora of the Semi-Desert Region of New Mexico: By John Weinzirl.

The study of the air-flora of our semi-desert region possesses considerable interest, especially since no similar investigation has been made under the same conditions. Our climate is characterized by extreme dryness, intense sunlight, hot summers and mild winters, and possesses considerable altitude.* Outside of the river valleys and in the mountain ranges, vegetation is scarce. Because of these facts it is generally supposed that practically no bacterial life exists here. In making this investigation, it was thought that simple petri plate exposures would give results sufficiently accurate for our purpose. Later a number of quantitative determinations were also made, a sand filter and aspirator can being used for this purpose. Regulation petri plates of approximately 3.5 inches internal diameter were used. Agar-agar seemed to be the most suitable medium, since the high colors of the air germs are especially prominent upon it. For comparative purposes, the number of bacteria falling upon the plates were reduced to a basis of 10 min. exposures. The number of plates exposed at one time was usually three, the results being averaged for the final figure. Seventeen exposures were made near the University of New Mexico, which is situated upon an elevated table land or 'mesa' east of Albuquerque. The time covered seven months—September to May. The number of bacteria falling upon the plates during 10 minutes was 35.8. The number fell as low as 3.8 in February, and rose to 71 in September. Thus the falling off in number during the winter season was quite marked. Comparative experiments were also made between the air of the 'mesa' and that of the residence and business districts of Albuquerque, the population of which is about 10,000. For approximate ratios we have 1:6 between mesa and residence district; and 1:80 between mesa and business district. Similar experiments were made to show the difference between the air in the morning and evening for residence and business parts of the city. For the former we have an approximate ratio of 1:4; and for the latter 1:5. It need scarcely be added that the great increase for the evening (6 P. M.) is due to the activities incident to city life. A special test of the altitude factor was made in the latter part of July, 1900, the Sandia Mts. being selected for the experiments. Plates were exposed in the usual way, at approximately 7,000 ft., 8,500 ft. and 10,000 ft.,

* The altitude of Albuquerque is nearly 5,000 feet.

the last number representing the highest peak. A considerable number of bacteria were obtained in each instance, the highest peak giving 18 per plate for 10 minutes. Quantitative determinations were made of the bacteria in mesa air and that of the residence district of Albuquerque. Five determinations (Nov.–Apr.) on the mesa gave an average of 41.6 bacteria per cubic meter or 1,000 liters. The eleven determinations in the city gave 143 bacteria per cubic meter. Both these results are lower than Miquel's figures for Mont-Souris park near Paris in winter, his average for 10 years being 170 per cubic meter. It would seem then, that the air of our semi-desert region is freer from bacteria life than other inhabited regions, but not as free as is popularly believed. The presence of a considerable number of bacteria in the air here, and even on the mountain tops is accounted for mainly by two factors, viz, large quantities of dust and relatively high winds. The extreme dryness facilitates dust formation and the high winds distribute what bacteria may be contained in the dust. As to the flora itself, it has already been noted that chromogenic species are prominent. Six out of fourteen species isolated are chromogens. Four of these are micrococci, viz, A_1 (salmon-pink), A_5 (pink), A_2 (sulphur-yellow) and A_4 (orange). Two are bacilli, A_6 (yellow) and A_{10} (pale-yellow). The remaining colonies are white or gray-white, and with the exception of A_8, all are bacilli. Apparently all the species are new. It is worthy of note that this flora is characteristic for a large area of territory as is shown by experiments made at Belen, Socorro, Magdalena, Magdalena Mts. and the Sandia Mts. previously mentioned. This includes territory more than 100 miles distant from Albuquerque. The wide distribution of this flora is undoubtedly due to the high winds which have a free sweep over the nearly barren mesas.

Field Experiments with Tomato Rot: By F. S. EARLE.

In a paper read before the Botanical Club at the Columbus meeting* it was pointed out that the 'black rot' or 'blossom end rot' of the tomato was caused by an undetermined species of *Bacillus;* and it was suggested that natural infections in the field were probably due to the agency of some small insect. Thrips were suggested as the possible agents of infection since they had frequently been observed in connection with the disease. It was also remarked that there seemed to be more hope in seeking remedies among the insecticides rather than among the fungicides. In order to test these views the following field experiments were carried out during the spring of 1900. It was hoped that some of the insecticides used might also be of benefit in controlling the fall worm. Nine plots were set with approximately 100 plants each. All were fertilized and cultivated alike and all were pruned to a single stem and were topped after setting the third fruit cluster. Plots 1, 8 and 9 were checks. The other plots were sprayed eight times each at intervals of three to five days with kerosene, whale oil soap and 'Rose Leaf' tobacco extract, singly and in combination as is shown by the following table. The kerosene was applied as a 10% mechanical mixture, the soap as a 1½ lb. to 1 gal. of water solution and the 'Rose Leaf' as a 1 pt. to 1 gal. solution. The kerosene proved to burn the foliage injuriously when applied with the other solutions and it was dropped from plots 3 and 6 after the third spraying. The whale oil soap solution also injured the foliage slightly. The plots were gone over every other day and all wormy and rotted fruits were removed and counted. The ripening fruits were also counted when picked and the

* Since published as a part of Ala. Exp. Sta. Bull., No. 109, pp. 20–25.

sound ones remaining on the vines at the close of the experiment.

Plot number.	Treatment, sprayed 8 times at 3 to 5 day intervals.	Total yield of fruits per 100 plants.	Number of rotted fruits per 100 plants.	Per cent. of rot.	Number of wormy fruits per 100 plants.	Per cent. of wormy fruits.
1.	Check.	1366	379	27	187	13
2.	10 per cent. mechanical mixture kerosene and water.	1417	301	21	378	26
3.	10 per cent. kerosene and whale oil soap, 1½ lbs. to 1 gal.	1495	384	25	407	27
4.	Whale oil soap, 1½ lbs. to 1 gal.	1309	243	18	456	39
5.	'Rose Leaf' tobacco extract, 1 pt. to 1 gal.	1467	202	13	443	32
6.	'Rose Leaf' as above and kerosene 10 per cent.	1355	170	12	513	37
7.	'Rose Leaf' as above, and whale oil soap as above.	1518	339	22	584	38
8.	Check.*	1490	188	12	589	39
9.	Check.	1241	177	14	526	42

As seen from the above table the number of rotted fruits varied from 12% to 27% in the different plots, the highest being one of the checks and the lowest also one of the checks and the plot receiving 'Rose Leaf' and kerosene. The average for all the plots was 20½%, for the three check plots it was 17⅔%, for the three plots receiving 'Rose Leaf' tobacco extract either alone or in combination, it was only 15⅔%, while for the three whale oil soap plots it rose to 21⅔%. These figures slightly favor the tobacco treatment, but as the average is only 27% less than that of the checks and only 5% less than the average for all the plots, while the different check plots varied among themselves as much as 15%, it seems best to consider the case as not proven. Thrips were almost entirely absent from the tomato plants this year and no other small insect was observed in sufficient numbers to account for the spread of the disease. It must be admitted that the problem of how natural infections occur is still unsolved, and that no remedy has been discovered. It was noted that on some vines nearly or quite all the fruits rotted, while on others in the same plot all remained sound. The high average in plots 1 and 3 was due to the condition of a few plants where all the fruits became diseased and plot 9 would have had a lower average than any but for a few plants in the outside row. It was also noted that dry weather favored the spread of the disease, while a period of daily showers would almost entirely prevent the appearance of new cases. This agrees with previous observations.

The number of wormy fruits varied from 13% in plot 1 to 42% in plot 9. This progressive increase in numbers indicates that in this case the position of the plot in the field rather than the treatment was the controlling factor.

* This plot was intended for Bordeaux mixture and Paris green, but owing to accident to spray pump, only one application was made and that is not believed to have affected the result.

Concentric Spore Spots: By B. D. Halsted.

The spores of parasitic fungi generally reach the surface of the host for aërial distribution by either the hyphæ of the fungus passing out through the stomata and afterwards bearing the spores free in the air, or in forming in masses just beneath the epidermis through which they break and thus become liberated. The peronosporas, cercosporas, ramularias and macrosporiums are good examples of the first named method, while the cystopus and gloeosporium are instances of the second type, which includes the vast number of members of the true rust fungi. In Æcidium and allied genera there is a special organ which envelops the spores, lifts the epidermis and bursts open as a deeply-seated cup. Similar to this is a large number of the *fungi imperfecti* with the septorias and phylostictas as types where the pycnidium makes a way through the epidermis and presents its mouth free for the discharge of the spores. Those fungi that produce their spores directly upon the surface through the stomata have their area of sporification defined by the distribution of the stomata and the veins and veinlets become boundary lines in many instances. When the fungus has the habit, as in the rusts, of massing the sporiferous hyphæ beneath the epidermis a new set of conditions is introduced. It is found in such, by microscopic examination, that the portion of the host just beneath the rupture is almost entirely replaced by the dense plexus of fungus hyphæ, and the host tissue is destroyed and the immediate threads are not favorably situated for further growth. At a short distance from the sorus in all directions the vitality is probably greater and new points of spore-production are established, resulting in a secondary circle of sori surrounding the original spore-spot. The development of this circle may be followed by a second ring of sori, each sorus more or less crescent-shaped until the host shows 'fairy rings' as real as those in the lawn or meadow and for a similar reason. Plants showing this concentric growth and fruitage of its fungous parasite are numerous. Among those best illustrating the phenomenon are *Cystopus candidus* (P.) upon Bursa, Nasturtium, and several other Cruciferæ; *Puccinia asparagi* DC. upon *Asparagus officinale* L.; *Puccinia Arenaria* (Schum) on *Dianthus barbatus* L.; and *Puccinia Hieracii ?* upon *Chrysanthemum Sinense* Sab. All of these were shown by means of microphotographs.

An Anthracnose and a Stem Rot of Antirrhinum majus: By F. C. Stewart.

Antirrhinum majus is subject to two destructive diseases: (1) An anthracnose caused by a new species of *Colletotrichum* for which the author proposes the name *Colletotrichum antirrhini;* (2) A stem rot caused by an undetermined species of *Phoma.*

The *Colletotrichum* is destructive to plants of all ages, at all seasons, both in the greenhouse and in the field. It produces numerous elliptical depressed spots on the stems and circular dead brown spots on the leaves. It fruits sparingly, except in a very moist atmosphere. It has been successfully combated by spraying the plants once a week with Bordeaux mixture. The *Phoma* attacks the stems, causing sections an inch or more in length to turn brown or black. The attack may be made at any point on the stems above ground but is most likely to occur a few inches below the tips of succulent shoots. The portion of the shoot beyond the point of infection quickly wilts and dies. Inoculation experiments with pure cultures of the *Phoma* have shown that it is an active parasite on succulent shoots but attacks woody stems with difficulty.

Notes upon Peltandra rust, Cæomurus Caladii (Schw.) Kunze Abstract: By F. H. Blodgett.

This rust was very abundant in the æcidial stage about the 15th of May, in a bed of hardy aquatics within the New York Botanical Garden. Some leaves were infested upon nearly every plant in the bed, and upon some, all the leaves were infested. Usually the upper portion of the petiole was most severely attacked. In the worst cases the midrib and its branches, and the petiole nearly to the water would be covered with the æcidia. In such cases the plants suffered severely from a bacterial rot affecting first the stems at those points most rusted, thence spreading, until the stem rotted away. Uredosori were not observed until June 7th; they became gradually more abundant, but at no time were they so virulent or so conspicuous as in the earlier stage. The uredosori were confined in many cases to the blade of the leaf, although occasionally found on the midrib and petiole. The uredospores bear a decided resemblance in shape, to those of the fern rust *Melampsorella aspidiotus* (Pk.) Mag., upon *Onoclea* and other marsh ferns.

A Mold Isolated from Tan-Bark Liquors: By Katharine L. Golden.

A mold was isolated from tan-bark liquors which were obtained from a tanning factory employing the liming process for unhairing the hides. The mold was present in both fresh, sweet and sour liquors. The mold is pink in color and has a characteristic floury appearance, due to the great number of spores formed. The organism fermented sucrose, dextrose and maltose. In most gelatine it grew profusely, developing a pronounced pink color, whereas in the ordinary meat gelatine the development was scanty and pale. Three distinct enzymes were developed by the action of the mold; a tryptic, a diastatic and a rennet enzyme; all three fairly active. The protoplasm in some of the larger hyphæ was strongly motile, though the hyphæ seemed to be possessed of septa. So far as could be determined by the aid of stains and by salts causing osmotic activity in the mold, the seeming septa are thickened rings on the outside of the filaments. The mold developed, in the various media used, an odor resembling that of tanned hides. No sexual organs were developed. Photo-micrographs and diagrams were used to show the appearance of the mold in the various stages of development.

The Embryo-sac of Peperomia pellucida: By Duncan S. Johnson.

The primary archesporial cell of *P. pellucida* is single and subepidermal. It cuts off a single tapetal cell above and then immediately develops to the embryo-sac. The nucleus of the embryo-sac divides by mitosis to sixteen similar nuclei, distributed about in the peripheral layer of cytoplasm. Two of these nuclei are soon found at the upper end of the sac with a rather larger portion of cytoplasm about each. The larger of these two nuclei with its cytoplasm forms the egg, the wall of which is at first very delicate and indistinct. The other seems to play the part of a synergid, and it also has no distinct wall until a much later stage. Eight of the remaining fourteen peripheral nuclei collect in a compact group, located near the lateral or basal wall of the embryo-sac, or often just below the egg. Before the male and female nuclei fuse these eight nuclei fuse together completely into one large nucleus which from this time behaves like the endosperm nucleus of the ordinary Angiosperm embryo-sac. This nucleus divides before any change is visible in the egg. A cell wall is formed immediately at each division, from the cell plate of the spindle, so that in the ripe seed there are forty or more endosperm cells, completely surrounding the embryo except above. The embryo at this time consists of twenty or more cells and reaches half way to the base of the embryo-sac. The remaining six peripheral nuclei are seen at this stage to be flattened against the wall of the but little enlarged embryo-sac by the endosperm cells and show signs of degeneration. The endosperm cells appear at this time to have protoplasmic contents only, but the whole tissue of the relatively much enlarged nucellus is densely packed with starch. The results here given agree with those recently published by Campbell, for this form up to the sixteen-nucleate stage of the embryo-sac. But he finds two synergidæ and interprets the group of eight nuclei as probably antipodals, which he thinks separate again later. He also apparently interprets as part of the embryo the mass of endosperm cells which finally fill most of the embryo-sac and therefore concludes that there is no endosperm.

A Contribution to a Knowledge of the Organogeny of the Flower and of the Embryology of the Caprifoliaceæ: By Nellie P. Hewins.

A study of the embryology of *Viburnum prunifolium* is interesting because the ovules of two of the locules of the tricarpellary ovary early become aborted, while the single ovule of the remaining locule develops normally. The functional ovule which occupies the largest locule attains the anatropous condition before the abortive ovules, from three to five in number, in each of the smaller locules, begin their development. The abortive ovules never become anatropous because of the mechanical conditions arising from lack of space in the locules, which are soon filled by the developing nucelli. The archesporial cell of the abortive ovules either divides to form two megaspores, each of which by successive divisions forms eight nuclei, or else it forms the embryo-sac directly, which in its completed state contains sixteen nuclei. The nuclei are similar in appearance and fail to become differentiated and arranged according to the usual plan of embryo-sacs. These abortive embryo-sacs persist until after fertilization, when they begin to disintegrate. The archesporial cell of the functional ovules divides to form two megaspores, the lower of which usually enlarges to become the embryo-sac. The polar nuclei fuse before anthesis. The antipodal apparatus, which consists of three large cells, increases in size after the formation of the endosperm nucleus until the differentiation of the egg apparatus, when it begins to disintegrate. The nucellar tissue, small in amount, disappears as the embryo-sac develops. The endosperm nucleus divides rapidly, after fertilization, by free-cell division. A bulky endosperm is soon formed and is surrounded by the integument; integumental cells infringing upon the endosperm constitute, as in certain other gamopetalæ, a tapetum, which does not disintegrate. An accumulation of food near the embryo is to be noted.

On the supposed Polymorphism of Eremosphæra viridis: By G. T. MOORE.

This unicellular alga has been the subject of considerable speculation as to its life history and consequent systematic position. De Bary who first described it, thought it might be a desmid, while De Wildeman believed it was more probably a zygospore than a desmid itself. De Toni suggested that *Eremosphæra* was nothing more than a prothallial condition of some fern, and Chodat, one of the most recent observers of this plant, has made out a remarkable case of polymorphism; finding stages resembling *Palmella*, *Schizochlamya*, *Centrosphæra* and other genera, in addition to the formation of zoospores. The author of the present paper has attempted, by means of pure cultures, to demonstrate the true affinities of the plant and after studies covering several years, comes to the conclusion that *Eremosphæra* has no other method of reproductiou than that of simple division, and that it cannot be related to any of the numerous genera it has been supposed to resemble. The paper will be published in full in the *Botanical Gazette*.

Note on Arceūthobiūm: By HERMANN VON SCHRENK.

The speaker described the method of seed distribution of these mistletoes, and the germination of the seed. Some large brooms formed by *Arceūthobium pusillum* on the black spruce were shown, and the occurrence of this species on the red spruce in the southern Adirondacks was reported.

The Origin of the Tannin in Galls: By HENRY KRAEMER.

In presenting some notes on the origin of tannin in galls the author limits his observations to examinations of the common 'ink ball' or 'oak-gall' which is produced on *Quercus coccinea* Wang, and *Q. imbricaria* Michx, probably by *Cynips aciculata* O. S. The galls are nearly globular in shape and mottled with a yellowish or greenish brown. When they fall from the tree the cell contents (besides the organized contents) are made up largely of starch grains. With the development of the larva certain changes are observed in the cell contents. If the galls are placed in solutions of copper acetate (7 per cent.) and allowed to remain for several weeks or months, there separates in the parenchyma cells of the middle zone yellowish crystals or crystalline masses, which may be lens-shaped, star-shaped or fan-shaped, much resembling the different carbohydrates as hesperidin, inulin, etc., which separate in certain plant cells when specimens are placed in alcohol. They are insoluble in water, alcohol, glycerin or chloral solutions. The appearance, reactions and a comparison with copper gallate crystals lead to the conclusion that they are of this composition. When the winged insect has developed, specimens which have been treated with copper acetate solutions show in the parenchyma cells numerous brownish-red tannin masses to which may be adhering some yellowish-brown crystals of gallic acid. The gallic acid appears to be formed at the expense of the starch in the gall during the chrysalis stage of the insect. With the development of the winged insect this then is changed (by simple condensation of two molecules of gallic acid with the loss of one molecule of water) to tannic acid.

A New Species-Hybrid, Salsify: By B. D. Halsted.

Tragopogon, a rather large genus of the Chicory family has two species in the flora of the United States, namely, *T. porrifolius* cultivated for its roots as the 'oyster plant' and a wild species the *T. pratensis* L. The cultivated species is in many ways very different from the wild form, being larger, but most strikingly in the heads of flowers. The *T. porrifolius* has purple corollas, while the *T. pratensis* has yellow and much smaller flowers. The hybrid obtained under garden culture is a close average between the two plants as to size, style of branching and the like, while the flowers are of a peculiar rose color. Perhaps the most interesting feature of the hybrid plants is their great vigor, they blooming profusely after the parent types are out of season and even dead and gone. The number of seeds produced in each head is small in the hybrids, not more than four usually, and a small fraction of the number in the heads of the parent. The individual seeds, however, in the hybrid are much larger than in the true *porrifolius* the larger of the parents. The hope of getting greater vigor of plant and size of root, with possibly a diminished tendency to disease in the hybrid than now found in the old garden form is fully sustained for the first year. Several photographs were shown of flower, fruit, etc.

The Development of the Ovule in Delphinium exaltatum Ait: By Louise B. Dunn.

The gynœcium of *Delphinium* consists normally of three separate carpels, each bearing two rows of anatropous ovules; the development of the ovule as far as determined was the usual angiosperm type. Some of the earlier stages of the embryo-sac were missed. The archesporial cell is one or two layers below the epidermis of the nucellus. The integuments arise first as two annular thickenings around the nucellus, but as the ovule becomes anatropous the integument appears single. The cells of the embryo-sac divide—until they number eight, and the endosperm nucleus is regularly formed by a fusion of two nuclei, one from each pole. The three gourd-shaped antipodal cells are unusually large before fertilization; as in *Aconitum* and others of the *Ranunculaceæ* they seem active from the appearance of their cytoplasm and the staining of the surrounding cells; mitosis also occurs in them sometimes. It is probable they have some physiological importance in transferring food from the chalazal portion of ovule to the embryo-sac, especially after fertilization, to the growing endosperm tissue. They persist until the embryo is fully formed and do not elongate (as in *Aconitum*) or multiply, but show no signs of degeneration even in the seed. The embryo is very small with heart-shaped cotyledons, and a hypocotyl about one-tenth their length. The suspensor is short, probably only one cell long. The endosperm tissue fills the entire embryo-sac, and is full of oil. The only interesting feature of the ovule development in *Delphinium* seems to be the added arguments in favor of regarding the antipodals as of present physiological use, and not as mere degenerating evidences of a tendency to produce spores in tetrads, or as a partial and functional homologue of the prothallus.

An Attempted New Method of Producing Zygospores in Rhizopus nigricans: By Louise B. Dunn.

The method consisted in cultivating spores of stock material of *Rhizopus* on a solid nutrient substance in test tubes. The stock material was the sporangial form, and usually produced zygospores in about a month when sown on sterilized bread. But on a mixture of Pfeffer's nutrient solution and enough gelatine to make it stiff at room temperature, the zygospores were produced in from 6 to 10 days. Trial cultures were also made in test tubes kept at 10° C. and in Petri dishes at room temperature, using the mixture as above; in Pfeffer's solution without the gelatine and on agar-agar. None of these cultures was successful, as only sporangia were formed.

This rapid production of the zygospores could not always be controlled, averaging three times out of five. Experiments to force zygospore formation in wild *Rhizopus* or *Mucor* have not been successful as yet, but it is hoped that future cultures may determine more definitely whether the results are due to confined space and lack of oxygen, to temperature conditions or to nutrient substance used.

The Composition of Endosperm and Milk of the Cocoanut: By J. E. Kirkwood and William J. Gies.

The authors supplemented the report of their work previously given before the New York Academy of Sciences (Science, 11, 12; 951, 1900), by presenting the results of later quantitative analyses: The following figures represent the average general composition of the endosperm: Water, 46%; solids, 54%. Of the latter 98.1% is organic and 1.9% inorganic; 43.4% is fat and 21.9% 'crude fiber.' The fresh endosperm contains 0.75% of nitrogen, which is equivalent to about 4.7% of 'albuminoid.' It is probable, however, that much of the nitrogen found exists in the form of 'extractives.' General analysis of the milk gave the following average data: Water, 95.3%; solids, 4.7%. Of the latter 88.5% is organic; 11.5% inorganic. Three dozen determinations of gross relationships gave the following average weights and percentages:

Weight of whole nut, 610 grams.	
Integument,	170 grams = 27.9%.
Endosperm,	333 grams = 54.5%.
Milk,	107 grams = 17.6%.

The volume of the milk averaged 105 c.c.

When Increase in Thickness begins in our Trees: By Geo. T. Hastings. Presented by W. W. Rowlee.

As far as could be ascertained no special attention has been given to the time when increase in thickness takes place in our trees. One finds only such general statements as this.* "The inner portion of any one annual ring . . . is formed in the spring; while the outer portion . . .

* Sachs, 'Physiology of Plants,' 1887, pp. 162.

has arisen towards the conclusion of the period of wood-forming activity." It was found that in the broad-leaved trees examined no increase in thickness took place until the buds had opened and the first leaves expanded; that the first formation of new wood was in the neighborhood of the terminal bud; that the first growth was not continnous around the stem, but of vessels and tracheids in irregular groups; that the growth was continued gradually from the one-year twig to the two- and three-year twigs; and that when the new wood begins to form on five- and six-year twigs the process becomes very rapid, seeming as if at that time growth began simultaneously over the whole tree. Growth usually begins and extends more rapidly on the upper more exposed limbs sometimes a week before any sign of growth can be seen on the lower limbs. In the pine an apparent exception was found, for increase in thickness began on two- and three-year twigs before it began on one-year twigs and before the buds had opened. By the time the buds were well opened the growth had extended from the terminal shoot down the trunk and growth was just beginning on the lower branches. This seems to be due to the leaves remaining on the twig for two or three years. In the hemlock, which holds its leaves for six or seven years, the growth, when examined about the end of May, was greatest on six-year twigs and decreased up to the one-year twigs where the growth was slight. On one of the deciduous Gymnosperms, the bald cypress (*Taxodium distichum*), the conditions seem to be as in the broad-leaved, deciduous trees; no growth in thickness begins till the leaves are expanded, and then it begins at the younger branches and extends back to the older ones.

On the Assimilation of some Organic Substances by Plants: By J. F. Clark.

The Rheotropism of Roots: By F. C. Newcombe.

North American Sordariaceæ: By David Griffiths.

The Development of the Egg and Fertilization of Pinus Strobus: By Margaret C. Ferguson.

Nuclear Division in the Hepaticæ: By B. M. Davis.

The History of the Bulbils of Lysimachia terrestris L.: By D. T. MacDougal.

Observation on Root Hairs: By W. J. Beal.

The root hairs of *Agrostemma Githago* L. and *Lilene notiflora* L. arise in vertical rows of epidermal cells, and those of the former are always extensions of the apical end, while they arise in the middle of cells in other species. Great variations in size and form were found, and septate hairs were seen on Chenopodium hybridum. Root hairs are extremely sensitive to changes of temperature and moisture.

D. T. MacDougal,
Secretary.

THE FAITH OF SCIENCE.*

It has been said that each man has one thing to say, and that when he speaks twice he repeats the second time what he said the first. I hope that the saying is not wholly true; and yet I fear that in my case there is a grain of truth in it. I was invited to speak a year ago to the Graduates' Club, and I suspect that I then said much that I am always tempted to say to graduate students. However, as your Dean has, for lack of better available material, invited me to address you at this your first meeting of the year, I must say something; and so I shall take down again the old fiddle, and give you what some of you will recognize as merely a variation upon the old tune.

* An address before the Graduate School of the University of Pennsylvania.

Several times this summer there has come into my mind a passage from an early work by Ernst Renan, in which he impresses one with the fact that it is melancholy to contemplate the bewildering masses of monographs with which the increasing specialization on the part of scholars threatens to flood the world.

Upon returning to the University this fall, and turning over the leaves of the new journals, the new books and the off-prints sent me by various friends and correspondents, I am impressed anew by the thought that, in every field of science, the swelling mass of material is indeed bewildering—I will even say appalling—and that the amount of attention that it is possible for any of us to bestow upon much of it seems a poor repayment to the author for his days and nights of a labor usually but poorly requited in the current coin of the realm. I am not speaking of papers printed for the sake of printing, precipitately created out of nothing at the fiat of a restless desire to keep one's self in evidence—the 'let there be noise,' which results in thunder not preceded by the illuminating flash. I speak of earnest efforts to add a little to the sum of human knowledge—a new historical fact dragged from some obscure and out of the way corner by a man who thinks it not without significance; an odd case of the use of the dative in mediæval Latin; a set of experiments, of perhaps doubtful import, on the borderland which separates psychology from physiology; a description of some rather uninteresting beetle; or an analysis of the argument of some equally uninteresting philosophical writer. Of printing for print's sake, many of you know my opinion. But what shall we say touching the numberless publications over which their authors have spent blood and sweat, and which seem to be read chiefly, if at all, by the ungrateful reviewer? When so few care to listen to the song,

> "What boots it, with incessant care,
> * * * * * * *
> To strictly meditate the thankless Muse?"

I speak to those who expect to devote their lives to science, and who, if they have within them any grain of modesty, will probably sometimes feel inclined to ask themselves seriously whether human life is really enriched in any appreciable degree by the fruit of their labors.

There have been ages in the world's history when such questionings would not so naturally have arisen. The many-sided intellectual curiosity which accompanied the new awakening of the world in the fourteenth and fifteenth centuries, did not find it necessary to enquire whether it 'paid' to establish the text of Cicero or to speculate touching the significance of Plato's Timæus. The greater the number of the intellectual enthusiasms alive at a given epoch, the less the likelihood that such a doubt as I have mentioned should arise in any given field. At every age, it is generally assumed that something or other is of importance, and the judgment of the age supports and incites to activity even the humblest worker in that particular field. Who would to-day think of doubting the value of the invention of a new air-brake, the discovery of a new process for obtaining dye-stuffs, or the devising of a new mechanical contrivance for quieting the baby. But scholars who spend their time upon matters which seem to have no connection with such things as these, are, perhaps naturally, called upon, from time to time, to give an account of their stewardship, and not infrequently have reason to doubt whether their contemporaries view their labors as of any value at all. No one likes to stand alone. He who is doubted comes to doubt himself; and he may even come to work in the half-hearted way natural to one without the enthusiasm which is born of faith.

What can I say to you in the face of

these things? Can I prove that every historical fact which may be discovered will be found to have a directly practical ethical or political significance? Can I show that all psychological experimentation is capital in the hands of the pedagogue? Does the discovery of every new beetle prove a boon to the agriculturist or to any one else? Are all philosophers so inspired that we may assume their words to be of value, whether we understand them or not? Manifestly, I can not prove these things, or show in just what respect human life has been enriched by a multitude of seekers after truth who have, perhaps, really succeeded in adding their modicum to the sum total of our knowledge.

Nor do I stand here with any desire to prove such things. The thought which I wish to bring before you is a very different one. It is that it is in no way incumbent upon you to give such a proof, or to torture yourselves with the idea that you must daily justify your labors by the exhibition of what is often called their practical importance. Science and letters would come to a sorry pass if it were regarded as indecorous for man to look upon the naked truth, and if she were held to be a fit object of contemplation only when bundled up in her working clothes and busied about the hearth or the loom. A too narrow attention to what is commonly called 'the practical' would sap the very foundations of progress; would defeat its own ends by cutting off that light which is our final guarantee of life and growth. Shall we close some of the windows in the house of life because this or that age prefers to have its light filtered through a particular medium? What may be the needs of man, the direction of development of society in the ages to succeed our own? Who can tell what knowledge will be found to be of the profoundest moment to those who come after us? Shall we, in our littleness, shut our eyes on the living miracle about us, except at such times as its light reveals just those objects which seem providentially intended for our particular dinner-pail? Some nonsense has, to be sure, been talked about 'truth for truth's sake'; 'truth,' we are apt to object, 'for the sake of life.' But in the larger faith of science, that faith without which the world could not have been where it now is, there is no truth that may not be of value to life; no truth that is not worthy of our highest endeavor.

Perhaps it will be admitted that truth should be sought in a generous spirit, and that, in the history of the human race, the army of those who have peered curiously into the mysteries of human life and the nature of things has played a part that cannot be overestimated. We have, it seems to me, a right to demand so much, at least, of all intelligent men. But the question remains: What can we say touching the individual value of the numberless units that have tramped wearily in the ranks? That the great captains have accomplished something notable few will deny. They have conquered the fair lands that we now cultivate. But how of the common soldier, whose very name is unknown, except to the few who busy themselves with the dusty records of an almost forgotten past, and love to loiter in the by-ways of curious learning? Has he existed to no purpose? Has he toiled in vain?

Surely not. He has done what he could. He has contributed his little to the enlightenment of the race; and out of his very errors, his perplexed and rather aimless marchings to and fro, there may have come a result he little expected and as little hoped. Only he who knows something of the history of human knowledge knows with what pangs of labor the modern world has been brought to the birth. It is an ancient fable that makes Minerva spring fully armed from the head of Jove. Not thus is knowledge born. Human enlightenment is a thing of small beginnings ; it is the outgrowth of the life of the race, not the magical creation of a few master minds. Many hands have labored to rear the great edifice, and he who has carried a single stone, even a small one, has not lived in vain.

"Nevertheless," one may whisper, "What if that stone should turn out to be no stone at all, but a clod of earth, and of no value to the building?" I answer: that is not your affair nor mine. Nature is prodigal of the means by which she attains her ends. We share with men in other walks of life the uncertainty as to the ultimate value of our particular labors. It is plainly necessary that there should be physicians and lawyers, and the rest; yet in view of the ignorance which hems us in, in view of the nearness of our horizon and the impossibility of predicting with certainty the remote consequences of human actions, who can dare to estimate the total accomplishment of this life or that? We are a part of a great whole; we must share in the life of the whole ; and those of us who are striving to carry our little grain of truth to the common board must rejoice in the wealth of the community, not grow despondent at the smallness of our contribution.

Let me invite you, then, to enter with joy upon your scientific labors. You can be called to no nobler work, and you must approach it in no doubting spirit. You must be inspired with a reverence for truth, and a faith in its priceless value for human life, that will carry you over periods of doubt and despondency; a faith that will gild with its mellow light the dry dust of your daily labor, and cast a ray into even those darker chambers in the blind walls of which you, with others, are striving to open a passage to the light of heaven.

And if you have this faith it will save you from that scientific intolerance which is not more tolerable than intolerance of other kinds. Do not narrow the meaning of the word 'science.' Let it be a synonym for openness of mind, patience, freedom from prejudice, a willingness to see the beauty and admit the importance of truths of many kinds. Do not undervalue the toil of men who delve in obscure corners of fields far remote from your own. The universe is, after all, but one; there is but one science, in the broadest sense of the word. The vibration of an atom, the unfolding of a flower, the structure of a mollusc, the instinct of a brute, and the reason of a man—what is there that does not call for investigation? If I may study the history and trace the development of a group of plants, why may I not investigate, in the same scientific spirit, not merely a group of languages, but a literature or a philosophy? This truth or that truth must not, in our minds, usurp the name of Truth; and the cause of science is not furthered by an enthusiasm which fails to see how many-sided truth is, and with what different instruments one may do good work in different departments. I lay some emphasis upon this point because, with increasing specialization—the natural result of an increase in human knowledge—there goes a certain danger. We cannot all work in all fields, of course; but if we have the truly scientific spirit, we shall value at its real worth faithful work done in every field. Fortunately for you, your association with each other here at the university will tend to open your eyes to the beauty of towers and pinnacles on the edifice of knowledge, which are taking their shape under other hands than your own.

In the name of my colleagues I bid you welcome to the work of the university; and I wish you a full measure of success.

George Stuart Fullerton.

University of Pennsylvania.

ADDRESS OF THE CHAIRMAN OF THE DEPARTMENT OF ASTRONOMY OF THE BRITISH ASSOCIATION.

It has been decided to form a Department of Astronomy under Section A, and I have been requested to give an address on the occasion. In looking up the records of the British Association to see what position astronomy has occupied, I was delighted to find, in the very first volume, 'A Report on the Progress of Astronomy during the Present Century,' made by the late Sir George Airy, so many years our Astronomer Royal, and at that time Plumian Professor of Astronomy at Cambridge. This report, made at the second meeting of the Association, describes, in a most interesting manner, the progress that was made during the first third of the century, and we can gather from it the state of astronomical matters at that time. The thought naturally occurred to me to give a report, on the same lines, to the end of this century, but a little consideration showed that it was impossible in the limited time at my disposal to give more than a bare outline of the progress made.

At the time this report was written we may say, in a general way, that the astronomy of that day concerned itself with the position of the heavenly bodies only, and, except for the greater precision of observation resulting from better instruments and the larger number of observatories at work, this, the gravitational side of astronomy, remains much as it was in Airy's time.

What has been aptly called the New or Physical Astronomy did not then exist. I propose to briefly compare the state of things then existing with the present state of the science, without dealing very particularly with the various causes operating to produce the change; to allude briefly to the new astronomy; and to speak rather fully about astronomical instruments generally, and of the lines on which it is most probable future developments will be made.

In this report * we find that at the beginning of the century the Greenwich Observatory was the only one in which observations were made on a regular system. The thirty-six stars, selected by Dr. Maskelyne, and the sun and moon were observed on the meridian with great regularity, the planets very rarely and only at particular parts of their orbits; small stars, or stars not included in the thirty-six, were seldom observed.

This state of affairs was no doubt greatly improved at the epoch of the report, but it contrasts strongly with the present work at Greenwich, where 5,000 stars were observed in 1899, in addition to the astrographic, spectroscopic, magnetic, meteorological and other work.

Many observatories, of great importance since, were about that time founded, those at Cambridge, Cape of Good Hope, and Paramatta having just been started. A list is given of the public observatories then existing, with the remark that the author is 'unaware that there is any public observatory in America, though there are,' he says, 'some able observers.'

The progress made since then is truly remarkable. The first public observatory in America was founded about the middle of the century, and now public and private observatories number about 150, while the instrumental equipment is in many cases superior to that of any other country. The prophetic opinion of Airy about American observers has been fully borne out. The discovery of two satellites to Mars by Hall in 1877, of a fifth satellite to Jupiter by Barnard in 1892, and the discovery of Hyperion by Bond, simultaneously with Lassall, in 1848, are notable achievements.

The enormous amount of work turned out by the Harvard Observatory and its

* *Brit. Assoc. Report*, 1831–32, p. 125.

branches in South America, all the photographic and spectroscopic work carried out by many different astronomers, and the new lines of research initiated show an amount of enthusiasm not excelled by any other country. A greater portion of the astronomical work in America has been on the lines of the new astronomy, but the old astronomy has not been at all neglected. In this branch pace has been kept with other countries.

From this report we gather that the mural quadrant at most of the observatories was about to be replaced by the divided circle. Troughton had perfected a method of dividing circles, which, as the author says, 'may be considered as the greatest improvement ever made in the art of instrument making.'

Two refractors of 11 and 12 inches aperture had just been imported into this country; clockwork for driving had been applied to the Dorpat and Paris equatorials, but the author had not seen either in a state of action.

The method of mounting instruments adopted by the Germans was rather severely criticised by the author, the general principle of their mounting being 'telescopes are always supported at the middle, not at the ends.'

"Every part is, if possible, supported by counterpoises."

"To these principles everything is sacrificed. For instance, in an equatorial the polar axis is to be supported in the middle by a counterpoise. This not only makes the instrument weak (as the axis must be single), but also introduces some inconvenience into the use of it. The telescope is on one side of the axis; on the other side is a counterpoise. Each end of the telescope has a counterpoise. A telescope thus mounted must, I should think, be very liable to tremor. If a person who is no mechanic and who has not used one of these instruments may presume to give an opinion, I should say that the Germans have made no improvement in instruments except in the excellence of workmanship."

I have no doubt that this question had often occupied Airy's mind, for in the Northumberland Equatorial Telescope which he designed shortly after for Cambridge he adopted what has been called the English form of mounting, where the telescope is supported by a pivot at each side, and a long polar axis is supported at each end. This telescope is in working order at the present time at Cambridge.

When he became Astronomer Royal he used the same design for what was for many years the great equatorial at Greenwich, though the wooden uprights forming the polar axis were in the Greenwich telescope replaced by iron. It says much for the excellence of the design and workmanship of this mounting, designed as it was for an object glass of about 13 inches diameter, when we find the present Astronomer Royal, Mr. Christie, has used it to carry a telescope of 28 inches aperture, and that it does this perfectly.

Notwithstanding the greater steadiness of the English form of mounting, the German form has been adopted generally for the mounting of the large refractors recently made.

There is much interesting matter in this report of an historical character.

As I have already said, the new astronomy, as we know it, did not exist, but in a report * on optics, in the same volume, by Sir David Brewster, we find that spectrum analysis was then occupying attention, and the last paragraph of this report is well worth quoting: "But whatever hypothesis be destined to embrace and explain this class of phenomena, the fact which I have mentioned opens an extensive field of inquiry. By the aid of the gaseous

* *Brit. Assoc. Rep.*, 1831–32, p. 308.

absorbent we may study with the minutest accuracy the action of the elements of material bodies in all their variety of combinations, upon definite and easily recognized rays of light, and we may discover curious analogies between their affinities and those which produce the fixed lines in the spectra of the stars. The apparatus, however, which is requisite to carry on such inquiries with success cannot be procured by individuals, and cannot even be used in ordinary apartments. Lenses of large diameter, accurate heliostats, and telescopes of large aperture are absolutely necessary for this purpose ; but with such auxiliaries it would be easy to construct optical combinations, by which the defective rays in the spectra of all the fixed stars down to the *tenth* magnitude might be observed, and by which we might study the effects of the very combustion which lights up the suns of other systems."

Brewster's words are almost prophetic, and it would almost appear as if he unknowingly held the key to the elucidation of the spectrum lines, for it was not until 1859 that Kirchhoff's discovery of the true origin of the dark lines was made.

Fraunhofer was the first to observe the spectra of the planets and the stars, and to notice the different types of stellar spectra. In 1817 he recorded the spectrum of Venus and Sirius, and later, in 1823, he described the spectrum of Mars ; also Castor, Pollux, Capella, Betelgeux, and Procyon.

Fraunhofer, Lamont, Donati, Brewster, Stokes, Gladstone, and others carried on their researches at a time when the principles of spectrum analysis were unknown, but immediately upon Kirchhoff's discovery great interest was awakened.

With spectrum analysis thus established, aided as it was later by the greater development of photography, the new astronomy was firmly established.

The memorable results arrived at by Kirchhoff were no sooner published than they were accepted without dissent. The works of Stokes, Foucault, and Angström at that period were all suggestive of the truth, but do not mark an epoch of discovery.

Astronomical spectroscopy divided itself naturally into two main branches, the one of the sun, the other of the stars, each having its many offshoots. I shall just mention a few points relating to each. The dark lines in the solar spectrum had already been mapped by Fraunhofer, and now it only needed better instruments and the application of laboratory spectra with Kirchhoff's principle to advance this work still further.

Fraunhofer had already pointed out the way in using gratings, and these were further improved by Nobert and Rutherfurd.

Kirchhoff's 'Map of the Solar Spectrum,' published in 1861–62, was the most complete up to that time ; but the scale of reference adopted by him was an arbitrary one, so that it was not long before this was improved upon. Angström published in 1868 his 'Map of the Normal Solar Spectrum,' adopting the natural scale of wave-lengths for reference, and this remained in use until quite recent times.

The increased accuracy in the ruling of gratings by Rutherfurd materially improved the efficiency of the solar spectroscope, but it was not until Professor Rowland's invention of the concave grating that this work gained any decisive impetus. The maps (first published in 1885) and tables (published in the years 1896–98) of the lines of the solar spectrum are now almost universally accepted and adopted as a standard of reference. These tables alone record about 10,000 lines in the spectrum of the sun, which is in marked contrast to the number 7 recorded by Wollaston at the beginning of the century (1802). Good work in the production of maps has also been done in this country by Higgs.

Michelson has also recently invented a new form of spectroscope called the 'Echelon,'* in which a grating with a relatively small number of lines is employed, the dispersion necessary for modern work being obtained by using a high order (say the hundredth) into which most of the light has been concentrated.

Besides lines recorded in the visual and ultra-violet portions of the solar spectrum, maps have been made of the lines in the infra-red, the most important being that of Langley's, published in 1894, prepared by the use of his 'bolometer.' Good work had, however, been done in this direction previously by Becquerel, Lamansky and Abney; the last, indeed, succeeded even in photographing a part of it.

The recording of the Fraunhofer lines in the solar spectrum is not all, however. The application of the spectroscope to the sun has several epoch-marking events attached to it, notably those of proving the solar character of the prominences and corona, the rendering visible of the prominences without the aid of an eclipse by the discovery of Lockyer and Janssen in 1868, the photography of the prominences both round the limb and those projected on the solar disc by the invention of the spectro-heliograph by Hale and Deslandres in 1890.

Success has not yet favored the many attempts to photograph the corona without an eclipse by spectroscopic means; but even now this problem is being attacked by Deslandres with the employment of the calorific rays.

Spectroscopic work on the sun has led to the discovery of many hundreds of dark lines, the counterparts of which it has not yet been possible to produce on the earth.

But besides those unknown substances which reveal their presence by dark lines, there were two others discovered, which showed themselves only by bright lines, the

* *Ast. Phys. Journ.*, Vol. VIII., 1898, p. 37.

one in the chromosphere, to which the name of Helium was given, and the other in the corona, to which the name of Coronium was applied.

The former was, however, identified terrestrially by Ramsay in 1895, though the latter is still undetermined. The revision of its wave-length, brought about by the observations of the eclipse of 1898, may, however, result in this element being transferred from the unknown to the known in the near future.

The study of stellar spectra was taken up by Huggins, Rutherfurd and Secchi. Rutherfurd* published in 1862 his results upon a number of stars, and suggested a rough classification of the white and yellow stars; but Secchi deserves the high credit of introducing the first systematic system of differentiation of the stars according to their spectra, he having begun a spectroscopic survey of the heavens for the purpose of classification,† whilst Huggins devoted himself to the thorough analysis of the spectra of a few stars.

The introduction of photography marks another epoch in the study of stellar spectra. Sir William Huggins applied photography as early as 1863,‡ and secured an impression of the spectrum of Sirius, but nearly another decade elapsed before Professor H. Draper § took a photograph of the spectrum of Vega in 1872, which was the first to record any lines. With the introduction of dry plates this branch of the new astronomy received another impetus, and the catalogues of stellar spectra have now become numerous. Among them may be mentioned those of Harvard College, Potsdam, Lockyer, McClean, and Huggins. The 'Draper Catalogue' || of the Harvard College, which is a

* *Am. Journ.*, Vol. XXXV., 1862, p. 77.

† *ComptesRendus*, T. LVII., 1853.

‡ *Phil. Trans.*, 1864, p. 428.

§ *Am. Journ. of Sc. and Arts*, Vol. XVIII., 1879, p. 421.

|| *Annals Harvard Coll.*, Vol. XXVII., 1890.

spectroscopic Durchmusterung, alone contains the spectra of 10,351 stars down to the 7–8 magnitudes, and this has further been extended by work at Arequipa, whilst Vogel and Müller, of Potsdam,* made a spectroscopic survey of the stars down to 7.5 magnitude between $-1°$ and $+20°$ declination. This has again been supplemented by Scheiner † ('Untersuchungen über die Spectra helleren Sterne'), and by Vogel and Wilsing ‡ ('Untersuchungen über die Spectra von 528 Sternen'). Lockyer § in 1892 published a series of large-scale photographs of the larger stars, and more recently McClean || has completed a spectroscopic survey of the stars of both hemispheres down to the $3\frac{1}{2}$ magnitude. For the study and investigation of special types of stars, the researches of Dunér on the red stars made at Upsala, and those of Keeler and Campbell on the bright line stars made at the Lick Observatory, deserve mention. For the study of stellar spectra the use of prisms in slit or objective prism spectroscopes has predominated, though more recently the use of specially ruled gratings has been attended by some degree of success at the Yerkes Observatory.

Several new stars have also been discovered by their spectra by Pickering in his routine work of charting the spectra of the stars in different portions of the sky. The photographic plate containing their peculiar spectra was, however, not examined in many cases until the star had died down again.

Spectrum analysis also opened up another field of inquiry, viz, that of the motion of the stars in the line of sight, based on the process of reasoning due to Doppler, and accordingly named Doppler's Principle.*

The observatories of Greenwich and Potsdam were among the first to apply this to the stars, and more recently Campbell at Lick, Newall at Cambridge, and Belopolsky at Pulkowa have made use of the same principle with enormous success.

It was also discovered that there are certain classes of stars having a large component velocity in the line of sight, which changes its direction from time to time, and in many such cases orbital motion has been proven, as in the case of Algol.

Another case of binary stars has also been discovered spectroscopically and explained by Doppler's principle. I refer to the stars known as spectroscopic binaries, in which the spectrum lines of one luminous source reciprocate over those from the other source of light, according as one is moving towards or away from the earth. This displacement of the spectrum lines led to the discovery of the duplicity of β Aurigæ, and ζ Ursæ Majoris by Pickering.†

Several other such stars have now been detected, notably β Lyræ, and lastly Capella discovered independently by Campbell ‡ at Lick, and Newall § at Cambridge.

The progress of the new astronomy is so closely bound up with that of photography that I shall briefly call to mind some of the many achievements in which photography has aided the astronomer.

Daguerre's invention in 1839 was almost immediately tried with the sun and moon, J. W. Draper and the two Bonds in America, Warren de la Rue in this country, and Foucault and Fizeau in France, being among the pioneers of celestial photog-

* *Astro-Phys. Obs. zu Potsdam*, Vol. III., 1882–83.

† Ibid., Vol. VII., 1895.

‡ Ibid., Vol. XII., 1899.

§ *Phil. Trans.*, Vol. CLXXXIV., A, 1893.

|| *Phil. Trans.*, Vol. CXCI., A, 1898.

* 'Ueber das farbige Licht der Doppelsterne,' . . . *Abhandl. der K. Böhmischen Ges. d. Wiss.* V. Folge, 2. Bd. 1843.

† *Am. Jour.* (3), 39, p. 46 (1890).

‡ *Astro-Phys. Jour.*, Vol. X., p. 177.

§ *Monthly Notices*, Vol. LX., p. 2 (1899).

raphy; but no real progress seems to have been made until after the introduction of the collodion process. Sir John Herschel in 1847 suggested the daily self-registration of the sun-spots to supersede drawings; and in 1857 the de la Rue photo-heliograph was installed at Kew. From 1858–72 a daily record was maintained by the Kew photo-heliograph, when the work was discontinued. Since 1873 the Kew series has been continued at Greenwich, which is supplemented by pictures from Dehra Dûn in India and from Mauritius. The standard size of the sun's disc on these photographs has now been for many years 8 inches, though for some time a 12-inch series was kept up.

The first recorded endeavor to employ photography for eclipse work dates back to 1851, when Berowsky obtained a daguerreotype of the solar prominences during the total eclipse. From that date nearly every total eclipse of the sun has been studied by the aid of photography.

In 1860 the first regularly planned attack on the problem by means of photography was made, when de la Rue and Secchi successfully photographed the prominences and traces of the corona, but it was not until 1869 that Professor Stephen Alexander obtained the first good photograph of the corona.

In recent years, from 1893 up to the total eclipse which occurred last May, photography has been employed to secure large-scale pictures of the corona. These were inaugurated in 1893 by Professor Schaeberle, who secured a 4-inch picture of the eclipsed sun in Chili; these have been exceeded by Professor Langley, who obtained a 15-inch picture of the corona in North Carolina during the eclipse of May, 1900.

Photography also supplied the key to the question of the prominences and corona being solar appendages, for pictures of the eclipsed sun taken in Spain in 1860 terminated this dispute with regard to the prominences, and finally to the corona in 1871.

In 1875, in addition to photographing the corona, attempts were made to photograph its spectrum, and at every eclipse since then the sensitized plate has been used to record both the spectrum of the chromosphere and the corona. The spectrum of the lower layers of the chromosphere was first successfully photographed during the total eclipse of 1896 in Nova Zembla by Mr. Shackleton, though seen by Young as early as 1870, and a new value was given to the wave-length of the coronal line (wrongly mapped by Young in 1869) from photographs taken by Mr. Fowler during the eclipse of 1898 (India).

Lunar photography has occupied the attention of various physicists from time to time, and when Daguerre's process was first enunciated, Arago proposed that the lunar surface should be studied by means of the photographically produced images.

In 1840 Dr. Draper succeeded in impressing a daguerreotype plate with a lunar image by the aid of a 5-inch refractor. The earliest lunar photographs, however, shown in England were due to Professor Bond, of the United States. These he exhibited at the Great Exhibition in 1851. Dancer, the optician, of Manchester, was perhaps the first Englishman who secured lunar images, but they were of small size.*

Another skillful observer was Crookes, who obtained images of 2 inches diameter with an 8-inch refractor of the Liverpool Observatory. In 1852 de la Rue began experimenting in lunar photography. He employed a reflector of some 10 feet focal length and about 13 inches diameter. A very complete account of his methods is given in a paper read before the British Association. Mr. Rutherfurd at a later date having tried an $11\frac{1}{2}$-inch refractor, and also

* Abney (Photography).

a 13-inch reflector, finally constructed a photographic refracting telescope, and produced some of the finest pictures of the moon that were ever taken until recent years. Also Henry Draper's picture of the moon taken September 3, 1863, remained unsurpassed for a quarter of a century.

Admirable photographs of the lunar surface have been published in recent years by the Lick Observatory and others. I myself devoted considerable attention to this subject at one time ; but only those surpassing anything before attempted have been published in 1896–99 by MM. Loëwy and Puiseux, taken with the Equatorial Coudé of the Paris Observatory.

Star prints were first secured at Harvard College, under the direction of W. C. Bond, in 1850 ; and his son, G. P. Bond, made in 1857 a most promising start with double-star measurements on sensitive plates, his subject being the well-known pair in the tail of the Great Bear. The competence of the photographic method to meet the stringent requirements of exact astronomy was still more decisively shown in 1866 by Dr. Gould's determination from his plates of nearly fifty stars in the Pleiades. Their comparison with Bessel's places for the same objects proved that the lapse of a score of years had made no difference in the configuration of that immemorial cluster ; and Professor Jacoby's recent measures of Rutherfurd's photographs taken in 1872 and 1874 enforce the same conclusion.

The above facts are so forcible that no wonder that at the Astrophotographic Congress held in Paris in 1887 it was decided to make a photographic survey of the heavens, and now eighteen photographic telescopes of 13 inches aperture are in operation in various parts of world, for the purpose of preparing the international astrographic chart, and it was hoped that the catalogue plates would be completed by 1900.

Photography has been applied so assiduously to the discovery of minor planets that something like 450 are now known, the most noteworthy, perhaps, as regards utility, being the discovery of Eros (433) in 1898 by Herr Witt at the Observatory of Urania, near Berlin.

With regard to the application of photography to recording the form of various nebulæ, it is interesting to quote a passage from Dick's 'Practical Astronomer,' published in 1845, as opposed to Herschel's opinion that the photography of a nebula would never be possible.

"It might, perhaps, be considered as beyond the bounds of probability to expect that even the distant nebulæ might thus be fixed, and a delineation of their objects produced, which shall be capable of being magnified by microscopes. But we ought to consider that the art is only in its infancy, and that plates of a more delicate nature than those hitherto used may yet be prepared, and that other properties of light may yet be discovered which shall facilitate such designs. For we ought now to set no boundaries to the discoveries of science, and to the practical applications of scientific discovery, which genius and art may accomplish."

It was not, however, until 1880 that Draper first photographed the Orion Nebula, and later by three years I succeeded in doing the same thing with an exposure of only thirty-seven minutes. In December, 1885, the brothers Henry by the aid of photography found that the Pleiades were involved in a nebula, part of which, however, had been seen by myself* with my 3-foot reflector in February, 1880, and later, February, 1886, it was also partly discerned at Pulkowa with the 30-inch reflector then newly erected.

* *Monthly Notices*, Vol. XL., p. 376.

Still more nebulosity was shown by Dr. Robert's photographs,* taken with his 20-inch reflector in October and December, 1886, when the whole western side of the group was shown to be involved in a vast nebula, whilst a later photograph taken by MM. Henry early in 1888 showed that practically the whole of the group was a shoal of nebulous matter.

In 1881 Draper and Janssen recorded the comet of that year by photography.

Huggins† succeeded in photographing a part of the spectrum of the same object, (Tebbutt's Comet, 1881, II.) on June 24th, and the Fraunhofer lines were amongst the photographic impressions, thus demonstrating that at least a part of the continuous spectrum is due to reflected sunlight. He also secured a similar result from Comet Wells.‡

I propose to consider the question of the telescope on the following lines: (1) The refractor and reflector from their inception to their present state; (2) The various modifications and improvements that have been made in mounting these instruments, and (3) the instrument that has been lately introduced by a combination of the two, refractor and reflector, a striking example of which exists now at the Paris Exhibition.

At a meeting of the British Association held nearly half a century ago (1852, Belfast) Sir David Brewster showed a plate of rock crystal worked in the form of a lens which had been recently found in Nineveh. Sir David Brewster asserted that this lens had been destined for optical purposes, and that it never was a dress ornament.

That the ancients were acquainted with the powers of a magnifying lens may be inferred from the delicacy and minuteness of the incised work on their seals and intaglios, which could only have been done by an eye aided by a lens of some sort.

* *Monthly Notices*, Vol. XLVII., p. 24.

† *Proc. Roy. Soc.*, Vol. XXXII., No. 213.

‡ *Rep. Brit. Assoc.*, 1882, p. 442.

There is, however, no direct evidence that the ancients were really acquainted with the refracting telescope, though Aristotle speaks of the tubes through which the ancients observed distant objects, and compares their effect to that of a well from the bottom of which the stars may be seen in daylight.* As an historical fact without any equivocations, however, there is no serious doubt that the telescope was invented in Holland.

The honor of being the originator has been claimed for three men, each of whom has had his partisans. Their names are Metius, Lippershey and Janssen.

Galileo himself says that it was through hearing that some one in France or Holland had made an instrument which magnified distant objects that he was led to inquire how such a result could be obtained.

The first publisher of a result or discovery, supposing such discovery to be honestly his own, ranks as the first inventor, and there is little doubt that Galileo was the first to show the world how to make a telescope.† His first telescope was made whilst on a visit to Venice, and he there exhibited a telescope *magnifying three times;* this was in May, 1609. Later telescopes which emanated from the hands of Galileo magnified successively four, seven and thirty times. This last number he never exceeded.

Greater magnifying power was not attained until Kepler explained the theory and some of the advantages of a telescope made of two convex lenses in his *Catoptrics* (1611). The first person to actually apply this to the telescope was Father Scheiner, who describes it in his *Rosa Ursina* (1630), and Wm. Gascoigne was the first to appreciate practically the chief advantages by

* *De Gen. Animalium*, Lib. V.

† Newcomb's *Astronomy*, p. 108.

his invention of the micrometer and application of telescopic sights to instruments of precision.

It was, however, not until about the middle of the seventeenth century that Kepler's telescope came to be nearly universal, and then chiefly because its field of view exceeded that of the Galilean.

The first powerful telescopes were made by Huyghens, and with one of these he discovered Titan (Saturn's brightest satellite): his telescopes magnified from forty-eight to ninety-two times, were about $2\frac{1}{3}$ inches aperture, with focal lengths ranging from 12 to 23 feet. By the aid of these he gave the first explanation of Saturn's ring, which he published in 1659.

Huyghens also states that he made object-glasses of 170 feet and 210 feet focal length; also one 300 feet long, but which magnified only 600 times; he also presented one of 123 feet to the Royal Society of London.

Auzout states that the best telescopes of Campani at Rome magnified 150 times, and were of 17 feet focal length. He himself is said to have made telescopes of from 300 to 600 feet focus, but it is improbable that they were ever put to practical use. Cassini discovered Saturn's fifth satellite (Rhea) in 1672, with a telescope made by Campani, magnifying about 150 times, whilst later, in 1684, he added the third and fourth satellites of the same planet to the list of his discoveries.

Although these telescopes were unwieldy, Bradley, with his usual persistency, actually determined the diameter of Venus in 1722 with a telescope of 212 feet focal length.

With such cumbersome instruments many devices were invented of pointing these *aerial telescopes*, as they were termed, to various parts of the sky. Huyghens contrived some ingenious arrangements for this purpose, and also for adjusting and centering the eyepiece, the object-glass and eyepiece being connected by a long braced rod.

It was not, however, until Dollond's invention of the achromatic object-glass in 1757–58 that the refracting telescope was materially improved, and even then the difficulty of obtaining large blocks of glass free from striæ limited the telescope as regards aperture, for even at the date of Airy's report we have seen that 12 inches was about the maximum aperture for an object-glass.

The work of improving glass dates back to 1784, when Guinand began experimenting with the manufacture of optical flint glass.

He conveyed his secrets to the firm of Fraunhofer and Utzschneider, whom he joined in 1805, and during the period he was there they made the 9.6 inches object-glass for the Dorpat telescope.

Merz and Mädler the successors of Fraunhofer, carried out successfully the methods handed down to them by Guinand and Fraunhofer.

Guinand communicated his secrets to his family before his death in 1823, and they entered into partnership with Bontemps. The latter afterwards joined the firm of Chance Bros., of Birmingham, and so some of Guinand's work came to England.

At the present day MM. Feil, of Paris, who are direct descendants of Guinand and Messrs. Chance Bros., of Birmingham, are the best-known manufacturers of large discs of optical glass.

It is related in history that Ptolemy Euergetes had caused to be erected on a lighthouse at Alexandria a piece of apparatus for discovering vessels a long way off; it has also been maintained that the instrument cited was a concave reflecting mirror, and it is possible to observe with the naked eye images formed by a concave mirror, and that such images are very bright.

Also the Romans were well acquainted with the concentrating power of concave mirrors, using them as burning mirrors, as they were called. The first application of an eye lens to the image formed by reflection from a concave mirror appears to have been made by Father Zucchi, an Italian Jesuit. His work was published in 1652, though it appears he employed such an instrument as early as 1616. The priority, however, of describing, if not making, a practical reflecting telescope belongs to Gregory, who, in his 'Optica Promota,' 1663, discusses the forms of images of objects produced by mirrors. He was well aware of the failure of all attempts to perfect telescopes by using lenses of various curvature, and proposed the form of reflecting telescope which bears his name.

Newton, however, was the first to construct a reflecting telescope, and with it he could see Jupiter's satellites, etc. Encouraged by this he made another of 6⅓ inches focal length, which magnified thirty-eight times, and this he presented to the Royal Society on the day of his election to the Society in 1671.

To Newton we owe also the idea of employing pitch, used in the working of the surfaces.

A third form of telescope was invented by Cassegrain in 1672. He substituted a small convex mirror for the concave mirror in Gregory's form, and thus rendered the telescope a little shorter.

Short also, from 1730–68, displayed uncommon ability in the manufacture of reflecting telescopes, and succeeded in giving true parabolic and elliptic figures to his specula, besides obtaining a high degree of polish upon them. In Short's first telescopes the specula were of glass, as suggested by Gregory, but it was not until after Liebig's discovery of the process of depositing a film of metallic silver upon a glass surface from a salt in solution that glass specula became almost universal, and thus replaced the metallic ones of earlier times.

Shortly after the announcement of Liebig's discovery Steinheil*—and later, independently, Foucault†—proposed to employ glass for the specula of telescopes, and, as is well known, this is done in all the large reflectors of to-day.

I now propose to deal with the various steps in the development of the telescope, which have resulted in the three forms that I take as examples of the highest development at the present time. These are the Yerkes telescope at Chicago, my own 5-foot reflector, and the telescope recently erected at the Paris Exhibition, dealing not only with the mountings, but with the principles of construction of each. When the telescope was first used all could be seen by holding it in the hand. As the magnifying power increased some kind of support would become absolutely necessary, and this would take the form of the altitude and azimuth stand, and the motion of the heavenly bodies would doubtless suggest the parallactic or equatorial movement, by which the telescope followed the object by one movement of an axis placed parallel to the pole. This did not come, however, immediately. The long focus telescopes of which I have spoken were sometimes used with a tube, but more often the object-glass was mounted in a long cell and suspended from the top of a pole, at the right height to be in a line between the observer and the object to be looked at; and it was so arranged that by means of a cord it could be brought into a fairly correct position. Notwithstanding the extreme awkwardness of this arrangement most excellent observations were made in the seventeenth century by the users of these telescopes. Then the achromatic telescope was invented and mechanical mountings were used, with circles for finding positions, much as we have them now. I have already mentioned the rivalry

* *Gaz. Univ. d'Augsburg*, March 24, 1856.

† *Comptes Rend.*, Vol. XLIV., February, 1857.

between the English and German forms of mountings, and Airy's preference for the English form. The general feeling amongst astronomers has, however, been largely in favor of the German mounting for refractors, due, no doubt, to a great extent, to the enormous advance in engineering skill. We have many examples of this form of mounting. A list of the principal large refracting and reflecting telescopes now existing is given. All the refractors in this list, with the exception of the Paris telescope of 50 inches and the Greenwich telescope of 28 inches, are mounted on the German form.

List of Large Telescopes in Existence in 1900.

Refractors 15 inches and upwards.	Inches.
Paris (Exhibition)	50
Yerkes	40
Lick	36
Pulkowa	30
Nice	29.9
Paris	28.9
Greenwich	28.0
Vienna	27.0
Washington, U. S.	26.0
Leander, McCormick Observatory, Vir.	26.0
Greenwich	26.0
Newall's, Cambridge	25.0
Cape of Good Hope	24.0
Harvard	24.0
Princeton, N. J., U. S.	23.0
Mount Etna	21.8
Strassburg	19.1
Milan	19.1
(Dearborn) Chicago	18.5
Warner Observatory, Rochester, U. S.	16.0
Washburn Observatory, Madison, Wis.	15.5
Edinburgh	15.1
Brussels	15.1
Madrid	15.0
Rio Janeiro	15.0
Paris	15.0
Sir William Huggins	15.0
Paris	15.0

Reflectors 2 feet 6 inches and upwards.	Ft.	In.
Lord Rosse	6	0
Dr. Common	5	0
Melbourne	4	0
Paris	4	0
Mendon	3	3
South Kensington	3	0
Crossley (Lick)	3	0
Greenwich	2	6
South Kensington	2	6

Some of these carry a reflector as well as, for instance, the telescope lately presented to the Greenwich Observatory by Sir Henry Thompson, which, in addition to a 26-inch refractor, carries a 30-inch reflector at the other end of the declination axis, such as had been previously used by Sir William Huggins and Dr. Roberts; the last, and perhaps the finest, example of the German form being the Yerkes telescope at Chicago.

The small reflector made by Sir Isaac Newton, probably the first ever made, and now at the Royal Society, is mounted on a ball, gripped by two curved pieces attached to the body of the telescope, which allows the telescope to be pointed in any direction. We have not much information as to the mounting of early reflectors. Sir William Herschel mounted his 4-foot telescope on a rough but admirably planned open-work mounting, capable of being turned round and with means to tilt the telescope to any required angle. This form was not very suitable for picking up objects or determining their position, except indirectly; but for the way it was used by Sir William Herschel it was most admirably adapted: the telescope being elevated to the required angle, it was left in that position, and became practically a transit instrument. All the objects passing through the field of view (which was of considerable extent, as the eye-piece could be moved in declination) were observed, and their places in time and declination noted, so that the positions of all these objects in the zone observed were obtained with a considerable degree of accuracy. It was on this plan that Sir John Herschel made his general catalogue of nebulæ, embracing all the nebulæ he could see in both hemispheres; a complete work by one man that is almost unique in the history of astronomy.

Sir William Herschel's mounting of his 4-foot reflector differs in almost every particular from the mountings of the long-focus telescopes we have just spoken of. The object-glass was at a height, the reflector was close to the ground. There was a tube to one telescope, but not to the other. The observer in one case stood on the ground, in the other he was on a stage at a considerable elevation. One pole sufficed with a cord for one; a whole mass of poles, wheels, pulleys and ropes surrounded the other. In one respect only were they alike —they both did fine work.

Lassell seems to have been the first to mount a reflector equatorially. He, like Herschel, made a 4-foot telescope, and this he mounted in this way. Lord Rosse mounted his telescopes somewhat after the manner of Sir William Herschel. The present earl has mounted a 3-foot equatorially.

A 4-foot telescope was made by Thomas Grubb for Melbourne, and this he mounted on the German plan. The telescope being a Cassegrain, the observer is practically on the ground level. A somewhat similar instrument exists at the Paris Observatory. Lassell's 4-foot was mounted in what is called a fork mounting, as is also my own 5-foot reflector, and this in some ways seems well adapted for reflectors of the Newtonian kind.

We now come to the Paris telescope. This is really the result of the combination of a reflector and a refractor. I cannot say when a plane mirror was first used to direct the light into a telescope for astronomical purposes. It seems first to have been suggested by Hooke, who, at a meeting of the Royal Society, when the difficulty of mounting the long-focus lenses of Huyghens was under discussion, pointed out that all difficulties would be done away with if, instead of giving movement to the huge telescope itself, a plane mirror were made to move in front of it.*

The Earl of Crawford, then Lord Lindsay, used a heliostat to direct the rays from the sun, on the occasion of the transit of Venus, through a lens of 40 feet focal length, in order to obtain photographs, and it was also largely used by the American observers on the same occasion.

Monsieur Loëwy at Paris proposed in 1871 a most ingenious telescope made by a combination of two plane mirrors and an achromatic object-glass, which he calls a Coudé telescope, which has some most important advantages. Chief amongst these that the observer sits in perfect comfort at the upper end of the polar axis, whence he need not move, and by suitable arrangements he can direct the telescope to any part of the visible heavens. Several have been made in France, including a large one of 24 inches aperture, erected at the Paris Observatory, and which has already made its mark by the production of perhaps the best photographs of the moon yet obtained. I have already spoken of Lord Lindsay and his 40-foot telescope, fed, as it were, with light from a heliostat. This is exactly the plan that has been followed in the design of the large telescope in the Paris Exhibition. But in place of a lens of 4 inches aperture and a heliostat a few inches larger, the Paris telescope has a plane mirror of 6 feet and a lens exceeding 4 feet in diameter, with a focal length of 186 feet. The cost of a mounting on the German plan and of a dome to shelter such an instrument would have been enormous. The form chosen is at once the best and cheapest. One of the great disadvantages is that from the nature of things it cannot take in the whole of the heavens. The heliostat form of mounting of the plane mirror causes a rotation of the image in the field of view which in many lines of research is a strong objection. There is much to be said on the other side. The dome is dispensed with, the tube, the equatorial mounting and the rising floor are not wanted. The mechanical arrangements of

* Lockyer, *Star-gazing*, p. 453.

importance are confined to the mounting of the necessary machinery to carry the large plane mirror and move it round at the proper rate. The telescope need not have any tube (that to the Paris telescope is of course only placed there for effect), as the flimsiest covering is enough if it excludes false light falling on the eye end; and more important than all, the observer sits at his ease in the dark chamber. This question of the observer, and the conditions under which he observes, is a most important one as regards both the quality and quantity of the work done.

We have watched the astronomer, first observing from the floor level; then mounted on a high scaffold like Sir William Herschel, Lassell, and Lord Rosse; then, starting again from the floor level and using the early achromatic telescope; then, as these grew in size, climbing up on observing chairs to suit the various positions of the eye end of the telescope, as we see in Mr. Newall's great telescope; then brought to the floor again by that excellent device of Sir Howard Grubb, the rising floor. This is in use with the Lick and the Yerkes telescopes, where the observer is practically always on the floor level, though constant attention is needed, and the circular motion has to be provided for by constant movement, to say nothing of the danger of the floor going wrong. Then we have the ideal condition, as in the Equatorial Coudé at the Paris Observatory, where the observer sits comfortably sheltered and looks down the telescope, and from this position can survey the whole of the visible heavens. The comfort of the observer is a most important matter, especially for the long exposures that are given to photographic plates, as well as for continued visual work. In such a form of telescope as that at Paris the heliostat form of mounting the plane mirror is most suitable, notwithstanding the rotation of the image. But there is another way in which a plane mirror can be mounted, and that is on the plan first proposed by Auguste many years ago, and lately brought forward again by Mons. Lippman, of Paris, and that is by simply mounting the plane mirror on a polar axis and parallel therewith, and causing the mirror to rotate at half the speed of the earth's rotation. Any part of the heavens seen by any person reflected from this mirror will appear to be fixed in space, and not partake of the apparent movement of the earth, so long as the mirror is kept moving at this rate. A telescope, therefore, directed to such a mirror can observe any heavenly body as if it were in an absolutely fixed position, so long as the angle of the mirror shall not be such as to make the reflected beam less than will fill the object-glass. There is one disadvantage in the cœlostat, as this instrument is called, and that is its suitability only for regions near the equator. The range above and below, however, is large enough to include the greater portion of the heavens, and that portion in which the solar system is included. Here the telescope must be moved in azimuth for different portions of the sky, as is fully explained by Professor Turner in Vol. LVI. of the *Monthly Notices* and it therefore becomes necessary to provide for moving the telescope in azimuth from time to time as different zones above or below the equator are observed. No instrument yet devised is suitable for all kinds of work, but this form, notwithstanding its defects, has so many and such important advantages that I think it will obviate the necessity of building any larger refractors on the usual models. The cost of producing a telescope much larger than the Yerkes on that model, in comparison with what could be done on the plan I now advocate, renders it most improbable that further money will be spent in that way. It may be asked: What are the lines of research which could be taken up by a telescope of this construction, and on what lines should the telescope be built? I will endeavor to answer this. All the work that is usually done by an astronomical telescope, excepting very long-continued observations, can be equally well done by the fixed telescope. But there are some special lines for which this form of research is admirably suited, such as photographs of the moon, which would be possible with a reflecting mirror of, say, 200 feet focal length, giving an image of some 2 feet diameter in a primary focus, or a larger image might be obtained either by a longer focus mirror or by a combination. It might even be worth while to build a special cœlostat for lunar photography, provided with an adjustment to the polar axis and a method of regulating the rate of clock to correct the irregular motion of the moon, and thus obtain absolutely fixed images on the photographic plate.

The advantage of large primary images in photography is now fully recognized. For all other kinds of astronomical photography a fixed telescope is admirably adapted ; and so with all spectroscopic investigations, a little consideration will show that the conditions under which these investigations can be pursued are almost ideal. As to the actual form such a construction would take ; we can easily imagine it. The large mirror mounted as a cœlostat in the center ; circular tracts around this center, on which a fan-shaped house can be traveled round to any azimuth, containing all the necessary apparatus for utilizing the light from the large plane mirror, so as to be easily moved round to the required position in azimuth for observation. In place of a fan-shaped house movable round the plane mirror, a permanent house might encircle the greater portion round the mirror, and in this house the telescope or whatever optical combination is used might be arranged on an open framework, supported on similar rails, so as to run round to any azimuth required. The simplicity of the arrangement and the enormous saving in cost would allow in any well-equipped observatory the use of a special instrument for special work. The French telescope has a mirror about 6 feet in diameter and a lens of about 4 feet. This is a great step in advance over the Yerkes telescope, and it may be some time before the glass for a lens greater than 50 inches diameter will be made, as the difficulty in making optical glass is undoubtedly very great. But with the plane mirror there will be no such difficulty, as 6 feet has already been made ; and so with a concave mirror there would be little difficulty in beginning with 6 feet or 7 feet. The way in which the mirror would be used, always hanging in a band, is the most favorable condition for good work, and the absence of motion during the observation, except of course, that of the plane mirror (which could be given by floating the polar axis and suitable mechanical arrangements, a motion of almost perfect regularity).

One extremely important thing in using silver or glass mirrors is the matter of resilvering from time to time. Up to quite recently the silvering of my 5-foot mirror was a long, uncertain, and expensive process. Now we have a method of silvering mirrors that is certain, quick and cheap. This takes away the one great disability from the silver or glass reflecting telescope, as the surface of silver can now be renewed with greater ease and in less time than the lenses of a large refracting telescope could be taken out and cleaned. It may be that we shall revert to speculum metal for our mirrors, or use some other deposited metal on glass ; but even as it is we have the silvered glass reflector, which at once allows an enormous advance in power. To do justice to any large telescope it should be erected in a position, as regards climate, where the conditions are as favorable as possible.

The invention of the telescope is to me the most beautiful ever made. Familiarity both in making and in using has only increased my admiration. With the exception of the microphone of the late Professor Hughes, which enabled one to hear otherwise inaudible sounds, sight is the only sense that we have been able to enormously increase in range. The telescope enables one to see distant objects as if they were at, say, one five-thousandth part of their distance, whilst the microscope renders visible objects so small as to be almost incredible. In order to appreciate better what optical aid does for the sense of sight, we can imagine the size of an eye, and therefore of a man, capable of seeing in a natural way what the ordinary eye sees by the aid of a large telescope, and, on the other hand, the size of a man and his eye that could see plainly small objects as we see them under a powerful microscope. The man in the first case would be several miles in height, and in the latter he would not exceed a very small fraction of an inch in height.

Photography also comes in as a further aid to the telescope, as it may possibly be to the microscope. For a certain amount of light is necessary to produce sensation in the eye. If this light is insufficient nothing is seen ; but owing to the accumulative effect of light on the photographic plate, photographs can be taken of objects otherwise invisible, as I pointed out years ago ; for in photographs I took in 1883 stars were shown on photographic plates that I could not see in the telescope. All photographs, when closely examined, are made up of a certain number of little dots, as it were, in the nature of stippling, and it is a very interesting point to consider the relation of the size and separation of these dots that form the image, and the rods and cones of the reckoner which determines the power of the eye.

Many years ago I tried to determine this question. I first took a photograph of the moon with a telescope of very short focus (as near as I could get it to the focus of the eye itself, which is about half an inch). The resulting photograph measured one two-hundredth of an inch in diameter, and when examined again with a microscope showed a fair amount of detail, in fact, very much as we see the moon with the naked eye ; making a picture of the moon by hand, on such a scale that each separate dot of which it was made corresponded with each separate sensitive point of the retina employed when viewing the moon without optical aid, I found, on looking at this picture at the proper distance, that it looked exactly like a real moon. In this case the distance of the dots was constant, making them larger or smaller, forming the light or shade of the picture.

I did not complete these experiments, but as far as I went I thought that there was good reason to believe that we could in this way increase the defining power of the eye. It is a subject well worthy of further consideration.

I know that in this imperfect and necessarily brief address I have been obliged to omit the names of many workers, but I cannot conclude without alluding to the part that the Association has played in fostering and aiding astronomy. A glance through the list of money grants shows that the help has been most liberal. In my youth I recollect the great value that we put on the 'British Association Catalogue of Stars'; we know the help that was given in its early days to the Kew Observatory ; and the reports of the Association show the great interest that has always been taken in our work. The formation of a separate Department of Astronomy is, I hope, a pledge that this interest will be continued, to the advantage of our science.

A. A. Common.

THE FOURTH INTERNATIONAL CONGRESS OF PSYCHOLOGY.

The Congress was held in Paris, in the Palace of Congresses on the Exposition grounds, from the 20th to the 25th of August, 1900. Its president was Professor Ribot, its vice-president Professor Richet, and its indefatigable secretary, on whom rested most of the work of organization, Dr. Pierre Janet. The registered membership numbered over 350, but a large proportion of these were not present. France was of course very fully represented, but the German and English contingents were small, and the American contingent lacked, among others, Professors James and Baldwin, who had expected to attend, but were prevented. Among the visitors present were Ebbinghaus, Külpe and O. Vogt, Ladd and Münsterberg, Sergi and Ferrari, Myers, Flournoy, Demoor, Tschisch, Mlle. Manacéine, and others whose writings are well known.

The Congress was divided into six sections: the physiological and comparative, under the presidency of Ives Delage; the introspective and philosophical, under Séailles; the experimental, under Binet; the pathological, under Magnan; hypnotism and suggestion, under Bernheim; and social psychology, under Tarde. The morning was usually devoted to section meetings, and the afternoon to general sessions.

The presidential address of Ribot was concerned with the progress made in psychology since the Munich Congress. Among the other principal addresses were those of Ebbinghaus, comparing the psychology of the present with that of 100 years ago; of Demoor, on the functions of nerve cells and of the cerebral cortex, as deduced from histological observations; of Sergi, on the treatment of consciousness in modern psychology; of Solokov, on 'colored hearing' considered as a sort of symbolism; of Tarkhanoff, on illusions and hallucinations of frogs.

Vogt aroused an animated discussion by attacking Flechsig's doctrine of association centers, and by denying any psychological value to anatomical studies of the brain.

Mlle. Manacéine presented the results of some experiments concerning the effects of different foods on the disposition of animals. She found dogs to be more tranquil and less quarrelsome on a vegetable diet than on a meat diet. In this connection, Richet reported similar observations of his own, leading to a similar conclusion, except that only *raw* meat differed in its psychic effects from a vegetable diet. On a diet of raw meat the dogs were more quarrelsome, but also more affectionate to their master; all their instincts and passions were sharpened.

Richet presented a remarkable musical prodigy in the person of a little boy who at the age of two and a half years had surprised his parents by spontaneously playing pieces on the piano. Now, after a year of training, he not only uses his tiny hands with considerable 'virtuosity,' but shows a wonderful memory for classical music, a genuine grasp of expression, ability to compose and improvise—in short, the mastery and independence of an artist. A strange fact is that the child can play only on the poor, broken-toned old piano on which he started. Every attempt to substitute a better instrument has led to failure.

Vaschide read a paper summarizing and adding to the evidence for the independence of the muscular and cutaneous senses. Cutting the cutaneous nerves does not demoralize the movements of an animal, as cutting *all* the sensory nerves does.

Alrutz reported some observations on the temperature sense. He is able to evoke a sensation of cold by stimulating the cold spots with warm objects (under certain conditions). The sensation of heat or burning, as distinguished from that of simple warmth, is, he believes, produced by the simultaneous stimulation of both hot spots and cold spots.

Mlle. Joteyko made it probable that the nerve centers are much more resistant to fatigue than the peripheral motor organs.

Schuyten reported, from the pedological bureau of the city of Antwerp (a unique institution), a series of tests of the muscular strength (grip) of pupils throughout the school year. In order to eliminate the effects of increase in age, he ascertained the age in months of each child, and tested him only in the month when he had a certain age, viz, 8 years 9 months in one series, 9 years 9 months in another. The results for the two series, and for girls and boys, showed a close parallelism. There was a gradual increase in strength from October to January, a fall from January to March and a rise again to June or July. March was the weakest month, June and July the strongest.

Netchaeff, of St. Petersburg, reported on some tests of the memory of school children for various sorts of impressions: objects seen, objects heard, names recalling visual, auditory or tactile impressions, names of emotions, abstract names and numbers. He found the memory to be best for objects seen, and next best for names of visual impressions; it was poorest, up to the age of 12 or 14, for names of emotions, and beyond that age for numbers and abstract names. The memory for numbers was always about as strong as for abstract names; and the increase in power to remember these two was, from 9 to 18 years of age, rather slight. The increase was greatest in case of objects seen and of words denoting emotions. The rapidity of the growth of memory fell off at puberty. The boys excelled the girls in remembering objects, the girls excelled in remembering names and numbers.

Psychical research was thoroughly ventilated at the Congress. Flournoy presented his observations on the celebrated medium Helen Smith. Myers and others testified to the remarkable revelations made by Mrs. Thompson—who, by the way, was present at the meetings, and certainly did not give one the impression of anything abnormal or uncanny. Encausse described some electrical apparatus for automatically recording the movements of mediums during a trance, so that their movements may be known, without the embarrassing presence of a scientific observer. Baraduc and others expounded queer ideas and demonstrated queerer-seeming facts relating to 'psychic exteriorization,' etc. Finally, a new psychical research society, the *Institut Psychique*, designed to have an international following, was inaugurated.

No great amount of new apparatus was exhibited at the Congress. Sommer presented some ingenious instruments for recording movements in three dimensions of the hand or leg, also for measuring the size of the pupil in reactions to light, emotions, etc. Scripture exhibited some of his color demonstration apparatus. In addition to this, Binet showed us his laboratory at the Sorbonne, equipped largely for the registration of movements, pulse changes, etc.; and Toulouse invited us out to the Asylum at Villejiuf, where he has installed a psychological laboratory equipped with several new forms of apparatus for testing sensations.

All the Parisian psychologists, in fact, were extremely hospitable. The visitors had every opportunity to meet them and each other, and the sociability of the Congress was one of its most successful features.

R. S. Woodworth.

SCIENTIFIC BOOKS.

Éléments de paléobotanique. By R. Zeiller. Paris, 1900. Carré et Naud. 8vo. Pp. 417. Illustrated.

The remarkable increase in accessions to our knowledge of fossil plants, which has taken place within the last two decades, coupled with a similar advance in our knowledge of existing species, and a recognition that a proper correlation of these two lines of botanical study must have an important bearing upon our knowledge of phylogenetic relations, has led botanists to look forward with confidence to the issue of works which would bring paleobotanical research into harmony with botanical knowledge in other directions, and serve to definitely eliminate the many errors and misconceptions consequent upon a copious but scattered literature, much of which had its origin at the hands of investigators who, although well qualified for their task in other respects, nevertheless lacked the essential element of special training and insight as botanists. In his 'Fossil Botany' issued in German in 1887, and reissued in an English edition in 1891, Solms-Laubach first opened the way to this reform, but his admirable work left much ground untouched. The expectations of botanists were more fully and most agreeably met by the issue of the first volume of Seward's 'Fossil Plants' in 1898, a work in thorough accord with the most recent views of botanical relationship and plant development, and which also possesses, among other excellent features, the great merit of having issued from the pen of one who is not only a thoroughly trained botanist, but one who has likewise acquired an intimate knowledge of geological facts. Before the completion of this epoch-making book, we are called upon to welcome another less pretentious, but nevertheless excellent work at the hands of a French author of wide repute. The extended experience as a paleontologist which M. Zeiller has enjoyed for many years, and the great excellence of his well-known publications on fossil plants, will serve to make this latest contribution from his pen a particularly welcome one to botanists.

The 'Éléments de paléobotanique' follows somewhat the same general scheme as Seward's 'Fossil Plants,' but it is much less complete in detail. The plan of treatment embraces a consideration of

1. The mode of preservation of fossil plants.
2. Classification and nomenclature.
3. A systematic treatment of the various groups of plants, commencing with the Thallophytes.
4. The succession of floras and relation to climatic conditions.
5. General considerations bearing upon the evolution of plant forms as indicated by the evidence of fossil plants.

The chapter on classification is devoted chiefly to general considerations and leaves much to be desired in the way of defining the author's position with respect to the relations of the various groups of plants. This is, however, the natural result of approaching the subject from the standpoint of the experienced geologist, rather than from that of the expert botanist, and a clearer conception of his point of view is gained from the subsequent section on a systematic treatment of the various groups, wherein he adopts a plan which, in some respects, can hardly be regarded as in accord with the most recent views of plant relationship. Such defects in systematic treatment, however, are of minor importance and are readily overlooked in considering the excellence of the material which he presents and which in many cases also has the added merit of freshness, practically extending the ground covered by Seward's types.

In the systematic section, the treatment of the algæ is brief, and hardly serves to convey an adequate idea of the extent to which the most delicate and perishable of all the plants found in a fossil state are preserved. A concise statement presents the leading facts relating to *Nematophycus* so far as published results are known—a plant which, while appropriately considered under forms of doubtful or uncertain relationship, is probably to be regarded as representing a generalized type which may eventually be found to include representatives of both the Siphonæ and Laminarieæ, although recently acquired evidence would seem to point to the latter in most cases. The Characeæ is dismissed with a short paragraph which, in spite of the relatively unimportant position which this group occupies among fossil plants, fails to convey an adequate idea of our knowledge concerning them, and entirely ignores their probable occurrence in paleozoic time. The fungi are briefly considered, and they are made to include the myxomycetes, the occurrence of which is very problematical, and the bacteria, of which two excellent illustrations are given—one of *Bacillus vorax* and one of *Micrococcus guignardi*.

The Bryophytes are dismissed with a short chapter which is in harmony with the fact that they constitute one of the least-known groups among fossil plants.

Attention appears to have been concentrated chiefly upon the vascular plants, of which the author presents a well-chosen selection of types and among which he seems well at home. The most noteworthy feature of this section of the work, and one which gives it special prominence in advance of previous publications, is the recognition for the first time, of the recently established Cycadofilicinæ which marks the most important advance in paleobotany within recent years, and at once indicates the nature of the data which a further study of fossil plants may be expected to contribute to our knowledge of the evolution of plant life.

The value of the book is greatly enhanced for the purposes of the working botanist or the student, by the superior character of the illustrations. Taken either by itself or in connection with Seward's more elaborate work, which it largely supplements, it affords a hand book of considerable utility.

D. P. Penhallow.

Montreal, Sept., 1900.

La spéléologie, ou science des cavernes. Par E. A. Martel. I volume, 8 vo., pp. 126, avec 10 figures. Prix 2 francs. Collection Scientia Série Biologique, No. 8. (Georges Carré et C. Naud, Editeurs, 3, rue Racine, Paris.)

A series of small volumes is being issued under the direction of MM. Milne-Edwards, Gaudry, Filhol, Balbiani, and other members of the Institute of France; one of the most recent of them being a hand-book on caverns and their contents. Its title, 'La spéléologie,' is coined from two Greek words, and means the Science of Caverns. This term is an improvement on the German 'Hœhlenkunde,' long in use in Austria, for the reason that the latter does not recognize the scientific claim on which emphasis is now laid; 'kunde' being the synonym of intelligence, or news, rather than of a classified knowledge. La Société de Spéléologie, of which M. Emilé Riviere is now president, and M. Edouard A. Martel the general secretary, is in the sixth year of its existence, numbers many eminent scientists among its members, with its headquarters at No. 7 rue des Grands-Augustins, Paris, whence it issues a regular bulletin telling the latest news from all parts of the known subterranean world, and publishing special contributions of scientific value. Important service has thus been done to geologists, archeologists, zoologists, hydrologists, mining engineers and hygienists. M. Martel has for many years devoted his summers to the exploration of caves in France, Spain, Greece, Switzerland, Austria, Belgium, Great Britain and elsewhere; and no man is better qualified than he to treat of the Science of Caverns, as he has so successfully done in the work under consideration.

'La spéléologie' is divided into sixteen chapters. The first chapter defines terms, corrects certain errors and prejudices, traces the history of under-ground exploration, gives a succinct bibliography of cave literature for a century, and indicates the many ways in which this branch of study has aided mankind. The second chapter deals with the causes producing caverns; which are mainly, first, pre-existing fissures in the rocks, due to earthquakes, volcanic eruptions, and other means by which the earth's crust has been rent asunder; and secondly, rain-water, charged with acids from the atmosphere and the soil, which seeks the fractures, faults and diaclases thus made, and enlarges them by erosion, corrosion, and hydrostatic pressure. This triple process is more fully explained in several successive chapters. Corrosion is exemplified by the destruction of gypsum and rock salt, and other soluble formations. Evidences of erosion abound in marine grottoes and volcanic caves. Columns of water weighing many atmospheres often stand in deep pits, or flow through secret conduits, bringing tremendous pressure upon the rocky strata before which they must yield.

The author deplores the prevalent confusion of nomenclature employed to describe the phenomena and results of aqueous agency. On pages 32 and 33 he spreads before the reader an elaborate table of the names by which pits, chasms, and other exterior and interior openings are designated in different countries of Europe and America; also offering suggestions as to unification or simplification of terms.

Ordinarily corrosion, erosion and hydrostatic pressure work simultaneously in cave-making. The acids eat into the softer portions of rock, leaving the harder parts as gravel, or sand, which the whirling or flowing water uses to grind a channel for drainage to an outlet.

M. Martel finds limited subterranean reservoirs, and also sheets of water held by saturation in mellow soils and porous strata, but denies the existence of vast bodies of water ('nappes d'eau'), such as are insisted on by certain ancient and modern authorities—even as recently as 1897—in order to explain the phenomena of artesian wells. He describes the sinking and resurgence of streams; and also a system of siphonage, which, as he remarks, belongs to hydrology rather than to speleology. Certain caves, however, are really but the channels of underground rivers whose waters have found some other bed.

The chapter on 'Abimes,' or natural pits, is peculiarly interesting, although, as the author admits, their origin has been an occasion of 'interminable controversy.' We cannot now follow him through his elaborate discussion of the theories of glacial grinding, of geyser chimneys, of interior excavation, the 'théorie du jalonnement' (*i. e.*, that they are drainage outlets for ancient lakes), and other theories. For this and much other interesting material the reader is referred to Martel's great work, 'Les abimes,' pp. 576, Paris, 1894. The theory finds favor that the abimes are generally due to exterior causes, working downward from the surface, rather than to interior forces. This is especially evident in the 'avens' that pierce the vast limestone plateaus, known as 'causses' —a term derived from the Latin 'calx.' Some of these avens drop vertically for from 200 to 700 feet, and then expand into vast chambers, occasionally with bodies of water, but often ending in numerous fissures of drainage.

M. Martel gives a list of abimes actually measured and known to be more than 200 meters in depth. The deepest of all is a perilous pit named in honor of its discoverer, M. David Martin, and located near Saint Disdier, amid the Hautes Alpes, at a point about 5,000 feet above the sea. Martel descended more than 1,000 feet vertically, and estimated the entire depth at about 1,600 feet. The writer of this review had the satisfaction personally, in 1897, of witnessing Martel's exploration of the Aven Armand, in Lozére, a pit more than 600 feet deep. The rope ladders, portable telephones and other apparatus made a striking display. In other pits that were intersected by streams a curious plan was taken for tracing the waters by discoloration by flourescein.

After describing stalactites, stalagmites and other forms of drip-stone, whose tendency is to obliterate caverns, and whose rate of growth has been recorded as indicating the age of the excavations in which they exist, M. Martel states the difficulties of the problem fairly, and concludes that it is impossible to affirm, in the actual state of our knowledge concerning subterranean channels, just when they began to exist; but he suggests the middle of the Tertiary epoch.

Particular attention is paid to the temperature of caverns, the purity or impurity of cave atmosphere, and the contamination of springs and subterranean reservoirs in relation to the public health. Natural ice-houses, and the theories of their formation, furnish material for an interesting chapter. Four causes are assigned, namely, the shape of the cavities, free access of snow in winter, altitude, and evaporation by currents of air. In this connection researches and adventures amid Alpine snow-pits are described. Cavern minerals are diversified. Among those mentioned are the various metallic ores, clays, carbonates, phosphates, and salts. Brilliant colors are often given to stalactites by copper and other metals.

Recent prehistoric explorations have been richly rewarded by relics found in cliff-dwellings and subterranean temples. Still more ancient are the remains of the paleolithic, neolithic and bronze ages. Many of the most noted of the inhabited caves and grottoes are mentioned by name. Living troglodytes are described, and also underground cemeteries, from which hundreds of human skeletons have been exhumed. Discoveries in the United States are by no means overlooked, particular mention being made of those in Pennsylvania, Indiana, Kentucky and Tennessee.

Subterranean fauna and flora, their origin, habitats, and the modification of their organs by adaptation to environment, fill the concluding chapter of this remarkable little volume. Directions are given for hunting cave animals and observing their habits. Authorities are conscientiously and carefully quoted, with fewer mistakes than might have been anticipated in a work of this comprehensive nature, and with evident intention to give due credit to investigators on both sides of the Atlantic.* In conclusion, we accept M. Martel's handbook as an admirable and timely contribution to current scientific literature.

Horace C. Hovey.

The Criminal: His Personnel and Environment. A Scientific Study. By August Drähms, with an introduction by C. Lombroso. New York, The Macmillan Co. 1900. 8vo. Pp. 402.

In a brief introduction to this book Professor Lombroso congratulates the author on his 'lucid exposition' and 'profound and original thought,' stating, further, that he has seldom met with so clear an exposition of his own views. This testimonial is not altogether calculated to carry weight, for even those who acknowledge a discriminating admiration for Lombroso's genius are well aware that a sound critical faculty is not one of the elements of that genius. It is possible that even the author himself may have been surprised at the excess of this appreciation; for Mr. Drähms is by no means so much in sympathy with Lombroso, as Lombroso is with Mr. Drähms. In his preface the latter states that "the strictly anthropological features here brought out have been accepted mainly as the properly accredited data of trained writers, the latchets of whose shoes I am not worthy to unloose, but whose conclusions nevertheless are taken under a general demurrer; in which respect, however, I have the consolation of knowing that I am in excellent company." Any one who carefully studies this statement will know how far this book is likely to prove useful to him; in its vague phraseology and its non-committal deference to people of all views, it is characteristic of the author's attitude throughout. He attempts to cover the whole field of criminal anthropology and criminal sociology. But not only do the original facts he has brought forward scarcely occupy a couple of pages; his acquaintance with the facts brought forward by others is nearly all second-hand, derived from sources already easily accessible in English, nor is any reference made to even the more important investigations of recent years, such as Winkler's attempt to deal with the data of criminal anthropology on a mathematical basis, or Steinmetz's studies of the evolution of punishment. He loosely discusses views to which he never gives precision by definite citation of authorities, and when he mentions authorities he is unable in a large proportion of cases even to spell their names. It is not impossible for a prison chaplain to do good work in this field, as Mr. W. D. Morrison has shown in England. But Mr. Drähms reveals no signs of that clear vision and intellectual grip which enable a man to conquer defects of scientific training. He takes a sane common-sense view of things, and as regards the treatment of criminals this leads him sometimes even to an advanced position, as when he advocates an unrestricted indeterminate sentence. But the possession of average sanity and common-sense is an inadequate equipment in writing a book which is prominently announced as 'a scientific study.'

It is necessary to state this clearly even at the risk of hurting the feelings of an amiable and well-intentioned writer. In the more abstract sciences there is no temptation to careless work; but in the anthropological and psychological sciences there is a temptation, even for an honest writer, to mask his scientific ineffectiveness under the human interest of his subject matter. In so far as he succeeds he discredits the science with which he occupies himself. The study of the criminal has suffered severely from this cause, and a book on

* On page 114 M. Martel inadvertently attributes to another my discovery of the prehistoric quarries of jasper and alabaster in Wyandot Cave, Indiana. My exploration was originally made in 1855, and my account of the quarries was published in the *Am. Jour. of Science and Art*, in 1878; whereas the account quoted from the *Proceedings* of the American Phil. Society did not appear till 1895.

this subject which proclaims itself as 'scientific' must expect severe scrutiny.

Mr. Drähms would have been well advised, and would have served better the cause of science, had he been content (like some French prison chaplains) to set down a brief and simple record of those things which during his residence in San Quentin he has himself seen and known.

HAVELOCK ELLIS.

BOOKS RECEIVED.

Physiology for the Laboratory. B. M. BROWN. Boston, Ginn & Co. 1900. Pp. viii + 167.

Laboratory Directions for Beginners in Bacteriology. VERANUS A. MOORE. Boston, Ginn & Co. 1900. 2d edition. Pp. xvi + 143.

SCIENTIFIC JOURNALS AND ARTICLES.

THE current issue of the *American Anthropologist*, Vol. II, No. 3, July–September, 1900, is of unusual interest, almost the entire field of anthropology being covered by the ten articles which comprise the principal part of its 200 pages. In his paper on 'Obsidian Mines of Hidalgo, Mexico,' Professor W. H. Holmes, of the National Museum, describes the process employed by the natives in obtaining obsidian during the centuries necessary to produce the flakage so thickly covering hundreds of acres on the mountain slopes, one heap alone being estimated to contain twenty or thirty thousand cubic feet of this artificially flaked material. The process of flaking is also described and illustrated. A complementary article, 'The Obsidian Razor of the Aztecs,' by Dr. George Grant MacCurdy, of Yale University, describes and explains the distinguishing features of obsidian fracture, and shows that to them is due, in a measure at least, the excellence of obsidian as a material for knife and razor making. Early last spring Dr. J. Walter Fewkes, of the Bureau of American Ethnology, made an examination of some remarkable but little-known cavate and pueblo ruins (the latter still standing several feet in height), northeast of Flagstaff, Arizona, and he also conducted some excavations therein. The results of these observations are now exploited (with several excellent views and ground-plan drawings) under the title 'Pueblo Ruins near Flagstaff, Arizona.' Judging from the character of the houses, the pottery and other art products, and his knowledge of the traditions of the Hopi Indians, the author is inclined to attribute these now-ruined pueblos to that tribe. An excellent article by Mrs. Alice Carter Cook is devoted to 'The Aborigines of the Canary Islands,' based on information obtained from personal observation in the archipelago and intimate acquaintance with the early Spanish literature of the subject. Every phase of the life of the people is described, and type pictures of the inhabitants and their curious dwellings are given. Still another corner of the world is treated in Mr. R. H. Mathews' paper on 'The Wombya Organization of the Australian Aborigines,' in which various unusual customs are also set forth. Dr. Swan M. Burnett presents a scholarly essay on 'Giuseppe Mazzini—Idealist: A Chapter in the Evolution of Social Science,' in which is given some portions of the great reformer's labors, with the underlying principles for which he contended with such courage and persistency as have rarely been equalled in the history of human endeavor. A 'Grammatic Sketch of the Catawba Language' of South Carolina is given by Dr. A. S. Gatschet. This almost extinct tongue belongs to the Siouan stock, and but few examples of it have ever been published. Mr. Gerard Fowke, whose wide experience in archeologic investigation of the Mississippi drainage area, and his familiarity with the supposed Norse remains in Massachusetts (first discovered and described by the late Professor E. W. Horsford, and later by his daughter, Miss Cornelia Horsford) make his study of the 'Points of Difference between Norse Remains and Indian Works most closely resembling them' of double interest. Mr. Harlan I. Smith, of the American Museum of Natural History, presents the details of his 'Archeological Investigations on the North Pacific Coast in 1899,' conducted under the auspices of the Jesup Expedition, and H. Newell Wardle discusses the interesting 'Sedna Cycle' of the Eskimo which sheds new light on the mythology of the most northerly inhabitants of the globe. The usual 'Book Reviews,' discussion of 'Periodical Literature,' and 'Notes and News' complete the number. (G. P. Putnam's Sons, Publishers, New York.)

But two articles of the October *Monist* are technically scientific in character. The first is by Professor A. S. Packard, of Brown University, and gives for the first time, in actual translations, a complete statement of Lamarck's views on the origin and evolution of man, and of his thoughts on morals, and on the relation between science and religion. Professor Packard believes that Lamarck's attempt at explaining the probable origin of man from some arboreal creature allied to the apes is more detailed and comprehensive than that offered by Darwin in his 'Descent of Man,' which was virtually anticipated by Lamarck. The second article, by Professor Arnold Emch, of the University of Colorado, treats of the 'Mathematical Principles of Esthetic Forms.' Starting from the physiological conditions for the perception of esthetic forms, the author proceeds to investigate the abstract law of symmetry as embodied in the principle of the group, projective and perspective transformation, inversion, etc., showing, for example, that the principle of repetition finds its mathematical expression in the geometry of the group, and explaining also why the various species of geometrical transformation do not destroy the impressions of axial and central symmetry. The remaining articles are: (1) an essay on modern Biblical criticism, by Professor Paul Schwartzkopff, entitled 'The Belief in the Resurrection of Jesus and its Permanent Significance'; (2) an illustrated paper on the 'Greek Mysteries as a Preparation for Christianity,' by Dr. Paul Carus; (3) 'The Ethics of Child-Study,' by Dr. Maximilian P. E. Groszmann; and (4) a report on the recent Psychological Congress at Paris. (Chicago: The Open Court Publishing Co.)

The Journal of Physical Chemistry, October. 'Toxic Action of Acid Sodium Salts on *Lupinus albus*,' by Louis Kahlenberg and Rollan M. Austin. Acid salts are found to be much more poisonous than they ought to be, assuming their toxicity to be due to the hydrogen ions only. 'Relationships between Thermodynamic Fundamental Functions,' by J. E. Trevor. 'The Boiling-points of Mixtures of Chloral and Water,' by Joseph C. Christensen. 'On the Emission and Absorption of Water Vapor by Colloidal Matter': correction, by P. Duhem. 'Quantitative Lecture Experiments on Electro-Chemistry,' by W. Lash Miller and Frank B. Kenrick. Description of an ingenious measuring instrument for rendering the results of experiments visible to a large audience, and a number of selected experiments.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A meeting of the Section was held on Monday, October 1st, at 12 West 31st Street.

Professor E. R. Von Nardroff presented a paper 'On the Application of Fizeau's Method to the Determination of the Velocity of Sound,' with an experimental illustration. He used sound of very short wave length, beyond the limits of hearing. The sound was detected by means of a sensitive flame. He overcame the effect of irregular disturbing reflected and diffracted waves by using sound of considerable intensity and a flame only slightly sensitive. The sound after passing between the teeth of a rapidly revolving wheel, fell on a concave spherical mirror made of wood, some distance away, and was reflected back through the teeth at the opposite end of a diameter of the wheel, and came to a focus on a sensitive flame just behind the wheel. The author gave a neat demonstration of the working of the apparatus, and showed with great ease how with increasing speed of the revolving wheel the flame was alternately shielded from and exposed to the sound. The slightest disturbance of the adjustment of the mirror threw the focus away from the flame in a marked manner. He stated that the method could probably not be used to compete with other accurate methods heretofore used, but it supplied a beautiful illustration of Fizeau's method of measuring the velocity of light.

Professor J. K. Rees gave an interesting account of some of the scientific instruments at the Paris Exhibition. The great telescope was not yet finished, although this fact was not yet generally known, and it was impossible to tell yet whether it was to be a success. The German exhibit was superb. The Germans had a method which ought to have been generally adopted, of arranging the instruments with each kind by the different makers in one case, instead of a complete line by each maker in a case by itself. An ingenious modification of Foucault's pendulum was seen at the Paris Observatory. It was only one meter long, but it showed the fact of the rotation of the earth after the lapse of fifteen seconds.

Professor Hallock described a peculiar lightning discharge he had observed at Lake Champlain. The flash came unexpectedly from a cloud about two miles from where the main shower was falling. It struck on a mass of rock, and on examining this it was found that instead of there being one or a few places where the lightning had struck, it was covered with innumerable little spots, each one indicating where a part of the flash had struck.

WILLIAM S. DAY,
Secretary.

NOTES ON PHYSICS.

THE GALTON WHISTLE.

IN the *Annalen der Physik* for July, 1900, Edelmann describes an improved form of the Galton whistle for use in studying the limits of audibility of high pitch sounds. This improved form of whistle is similar to the locomotive whistle in design, the vibrating air column being from 2 to 4 millimeters in diameter and from 0.7 to 5 or more millimeters in length. With a whistle 2 mm. in diameter Edelmann has produced sound waves, using the word sound in its physical sense, of 2 mm. wavelength, corresponding to a vibration frequency of 170,000 double vibrations per second. This is nearly an octave higher than the highest pitch obtained by König in 1899.

Edelmann determined the pitch by measuring the wave-length of the sound as indicated by Kundt's dust figures, in an elongated glass tube resonator. This resonator for the very high pitch waves was less than a millimeter in diameter of bore and about ten millimeters in length.

The present writer remembers well a very striking lecture experiment by Professor Kundt in 1890, in which the pitch limit of audibility was demonstrated by a Galton whistle, the actual existence of the physical sound, when the whistle was adjusted to give more than about 40,000 vibrations per second, was beautifully shown to a large audience by the effect of the whistle upon a sensitive gas flame.

THE GENESIS OF THE IONS IN THE DISCHARGE OF ELECTRICITY THROUGH GASES.

THE phenomena of the electric discharge through gases seemed only a few years ago to be so complicated that physicists almost despaired of finding an hypothesis which might bring order out of the mass of experimental results which had accumulated.

The discovery of the Röntgen rays stimulated research in this field greatly, and the observation that these rays in passing through a gas cause it to become an electrical conductor soon gave fixedness to the idea that a gas conducts electricity by having its molecules broken up into positively and negatively charged parts or ions which wander about through the gas.

This ionic hypothesis has already been of great value in suggesting lines of research ; and the rapidly accumulating results of these recent researches, interpreted, of course, through the ionic hypothesis itself, show, under the widest variety of conditions, a degree of consistency which is rapidly giving to the ionic hypothesis the dignity of an established theory.

Some of the most striking applications of the ionic hypothesis have been noted in SCIENCE during the past three years.

PROFESSOR J. J. THOMSON, in the *Philosophical Magazine* for September, points out in a paper entitled 'The genesis of the ions in the discharge of electricity, through gases,' why the dielectric strength of a gas is approximately proportional to the pressure of the gas; why the dielectric strength of a thin layer of gas is greater than the dielectric strength (volts per centimeter) of a thick layer of the same gas; and he explains the striations of the positive column or glow in a Geissler tube.

The reader should keep in mind that the scientific explanation of a thing is a description of the thing in the simplest possible terms. Many scientists feel an objection to the use of the word *explanation* in that its use tends to confirm a hearer in the acceptance of the figments of his imagination not simply as a model of the world (for this is to some extent a practical necessity), but as the world itself. As Münsterberg puts it: The greatest danger of the present day in education is the confusion of boundaries between our logical constructions and the teleological realms.

W. S. F.

SCIENTIFIC NOTES AND NEWS.

The National Academy of Sciences will hold its autumn meeting at Brown University on November 13th, 14th and 15th.

The American Society of Naturalists will meet at Baltimore on December 27th and 28th, and with it the affiliated societies devoted to natural history. Christmas day comes this year on Tuesday, and the balance of the week scarcely gives a suitable time for the meetings of those societies whose sessions last longer than two days.

It is reported that Sir John Murray, who is now engaged in an expedition to Christmas Island, will later join Professor Haeckel in Java. It will be remembered that the latter is searching for remains of *Pithecanthropus erectus*.

The Senate of New York University has received and confirmed the votes of its judges selecting thirty eminent native-born Americans whose names are to be inscribed in the 'Hall of Fame.' The Americans selected as the most eminent are distributed as follows: Rulers and statesmen, 7; authors, 4; inventors, 4; preachers and theologians, 3; judges and lawyers, 3; soldiers and sailors, 3; men of science, 2; philanthropists, 2; educators, 1; painters, 1. The inventors on this list are Fulton, Morse, Whitney and Howe, and the men of science Audubon and Gray. Franklin is of course also included. Ninety-seven judges voted and the votes cast for men of science were as follows: John James Audubon, 67; Asa Gray, 51; Joseph Henry, 44; Matthew Fontaine Maury, 20; Benjamin Thompson, 19; Benjamin Silliman, 16; Benjamin Peirce, 14; Nathaniel Bowditch, 10; Alexander B. Bache, 9; Spencer Baird, 8; Henry Draper, 8; Maria Mitchell, 7; David Rittenhouse, 6. Twenty further names are to be selected in 1902 by the same judges who may vote for those who received at least 10 votes in the present competition.

The death is announced of Dr. R. J. Kupper, formerly professor of geometry in the German Technical Institute of Prague.

The *Bulletin* of the American Mathematical Society states that the Steiner prizes of 6,000 Marks, which were not awarded, owing to no papers being presented, have been divided into three parts which have been given to Dr. Karl Friedrich Geiser, professor at the polytechnic school at Zurich, for his individual researches in geometry and his services in the publication of Steiner's lectures; to David Hilbert, professor in the University of Göttingen, for his important researches on the axioms of geometry and for the advancement which analytic geometry has experienced from his work on the theory of invariants, and to Dr. Ferdinand Lindemann, professor at the University of Munich who has earned special distinction in geometry by his celebrated discussion of the quadrature of the circle, as well as by editing Clebsch's 'Vorlesungen über Geometrie.'

The Hufeland Society, of Berlin, offers two prizes of 800 Marks for researches on the following subjects: (1) On the influence of salts in drinking water on the constitution of the blood and (2) The influence of thermal and mechanical stimuli on the circulation of the blood. The papers, which may be written in English, must be sent to Professor O. Liebreich, Neustadtische Kirsch Strasse 9, Berlin, prior to March 1, 1901.

A civil service examination will be held on November 20th for the position of assistant in serum therapeutics, Biochemic Division, Bureau of Animal Industry, Department of Agriculture. The salary of the position is $720 per annum, and the examination will be chiefly on serum therapeutics and elementary general chemistry.

No news has been received from the *Windward* later than August 10th, at which date, however, it had safely arrived at Godhaven, half way to Cape York.

It is reported that Mr. Ziegler of New York will defray the expenses of an expedition to the North Polar regions under the direction of Mr. E. P. Baldwin who accompanied Lieutenant Peary as meteorologist in 1893–94. The plan is to have an elaborately equipped expedition with specialists in the different sciences and to start early next year.

The medical works contained in the library of the late Dr. Alfred Stillé, of Philadelphia, have been bequeathed by him to the College of Physicians. The estate is left to relatives, but if they leave no heirs it also will go to the College of Physicians.

A library known as the 'Seymour Technical Library' is to be established by friends of the late Major L. T. Seymour at Johannesberg, as a memorial to his services to the mining industry in South Africa.

The appropriation made by the British government for the eight agricultural colleges of England and Wales is £7,750. These colleges have all been established within the past ten years.

The new National Museum at Munich, containing the collection of Bavarian antiquities, has been opened, and the valuable collections can be viewed to much better advantage than hitherto. The building contains more than a hundred rooms and has been erected at a cost of about $1,000,000.

The Authors' Catalogue of the British Museum, containing four hundred large volumes and numerous supplements, has now been completed. The compilation of the catalogue has occupied twenty years and cost $200,000. A subject-catalogue is now in course of preparation.

Lord Lister gave the third Huxley lecture at the Charing Cross Medical School on October 2d, his subject being 'Recent Advances in Science and their bearing on Medicine and Surgery.' He described in some detail the physiological and pathological investigations that led to his great discovery. It will be remembered that these lectures before the Charing Cross Hospital Medical School were endowed as a memorial to Huxley, and are given once in two years. The previous lecturers have been Sir Michael Foster and Professor Virchow.

At the Geographical Congress at Berlin in October, 1899, it was decided to form an International Seismological Society. The first meeting of the delegates will be held at Strassburg, April 11, 1901. The principal subjects chosen for discussion are: 'The organization and extension of investigation in different countries'; 'The selection of apparatus for international and local observations'; 'The annual publication of international reports,' and 'The status of the new society.'

The attendance at the seventy-second annual meeting of German Men of Science and Physicians was about 1,100.

At the Geodetic Congress which met at Paris at the end of last month, Sir David Gill, director of the Cape Town Observatory, reported the progress made in measuring an arc of meridian of 104 degrees from the Cape to Alexandria. They were passing by permission through German East Africa. Five degrees had been already measured in Rhodesia and three and a half in Natal. The measurement by international cooperation of an arc from French Congo to German East Africa was considered. A report was also made to the effect that the measurement of the geodetic line between Malta and Sicily had been successfully carried out under the superintendence of Dr. Guarducci, the chief of the geodetic division of the Italian Geographical Institute. The Malta station was at Gozo, and the chief Sicilian stations were on the mountains of Etna and Cammarata. The distance between Malta and Sicily is about 125 miles, and signals were exchanged at this distance by means of the oxy-acetylene search light.

The *British Medical Journal* states that the Association des Anatomistes, which was founded last year, held its second meeting in Paris recently. The session was devoted to the discussion of business matters, the Association having for purposes of scientific work joined forces with the Section of Anatomy and of Histology and Embryology of the International Congress of Medicine. In the absence of Professor Mathias Duval, the chair was taken by Professor Henneguy, of the Collège de France. It was decided that the next meeting should be at Lyons in 1901, on Monday, Tuesday and Wednesday of the last week before Easter, under the presidency of M. Renaut, with MM. Testut, Arloing and Ledouble as Vice-Presidents. Thirty-two new members were admitted, among them being Professors Waldeyer, His, Golgi, and Eternod. The Secretary of the Association is Professor Nicolas, Faculté de Médecine, Nancy.

UNIVERSITY AND EDUCATIONAL NEWS.

The formal inauguration of Dr. Henry S. Pritchett as President of the Massachusetts Institute of Technology will take place on October 24th.

The Trustees of Western Reserve University have voted to erect a new chemical laboratory for the work under the charge of Professor E. W. Morley.

Mr. Alfred L. Jones, of Liverpool, has offered £1,000 a year for five years towards a fund for establishing a comprehensive system of technical education in Wales.

A students' observatory has lately been opened at Wellesley College, built and equipped by the enlightened liberality of one of the Trustees, Mrs. John C. Whitin. That the building is unusually beautiful, of white marble, with roof of ribbed copper, has not been allowed to detract from the equipment. A twelve-inch refractor of Alvan Clark & Sons, a three inch transit, a six-foot focus concave grating spectroscope and other necessary instruments are or soon will be in place. The dome by Warner & Swazey works easily, as it should in a woman's observatory, and is of graceful design, a hemisphere upon a cylinder. The address at the opening was by Professor E. C. Pickering. Greetings from Lady Huggins, Miss Agnes Clarke and Miss Dorothea Klumpke were read, and Professor David P. Todd spoke of 'Laboratory work in Astronomy.' Courses both in physical astronomy and mathematical astronomy are already initiated under the conduct of Professor S. F. Whiting and Professor Ellen Hayes.

The annual commemoration exercises will be held at Princeton University on October 20th. The address this year will be by Bishop Satterlee, of Washington.

It is reported that Dr. Adams will not again resume the duties of the presidency of the University of Wisconsin, but that Dr. E. A. Birge, professor of zoology and now acting president, will be installed as president.

Professor R. H. Chittenden, director of the Sheffield Scientific School of Yale University and professor of physiological chemistry, has been made professor of physiology in the Yale Medical School.

J. W. Feeley, M.S., professor of physics and geology at Wells College, Aurora, N. Y., has been appointed acting president in the place of Dr. W. E. Waters, who has resigned.

Mr. Hugo Diemer has been elected assistant professor of mechanical engineering at the Michigan State Agricultural College. He was formerly the head of the mechanical department of the Agricultural and Mechanical College at Greensborough, N. C.

Professor W. F. M. Goss has been elected dean of the engineering school of Purdue University.

Professor Roberts Latta, lecturer in logic and philosophy in the University of St. Andrews, has been appointed to the chair of moral philosophy in the University of Aberdeen, vacant by the transfer of Professor Sorley to the corresponding chair at Cambridge University.

Lawrence E. Griffin, Ph.D. (Johns Hopkins University), has been appointed instructor in zoology in Western Reserve University.

J. B. Faught has been appointed professor of mathematics in Michigan Northern Normal School at Marquette, Michigan.

Richard K. Piez, Pd.D. (New York University), has been appointed professor of psychology at the State Normal School, Oswego, N. Y. Dr. Piez assumed the duties of his chair upon his recent return from a special tour in Europe, in which he made a study of the applications of modern pedagogy in the actual work of continental schools. Pitt. P. Colgrove, Pd.D. (1900), has resumed his duties at the State Normal School, St. Cloud, Minn., after a leave of absence extending over two years, which he spent in study at the University. Dr. Colgrove will have charge of the departments of psychology and mathematics.

SCIENCE

Friday, October 26, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE INTERFERENCES OBSERVED ON VIEWING ONE COARSE GRATING THROUGH ANOTHER, AND ON THE PROJECTION OF ONE PIECE OF WIRE GAUZE BY A PARALLEL PIECE.

It has often been a matter of surprise to me that the shadow bands observed, for instance, on looking through one distant picket fence at another, are so seldom referred to in the literature of physics; and moreover, that phenomena so ubiquitous and of such remarkable properties are sparingly, if ever, made use of by the practical physicist. I therefore thought it worth while to look into the subject experimentally, for my own satisfaction, and the results may be of interest to the reader. I hope to show that there is probably no more straightforward example of the diffraction method in geometric optics, or more instructive method of introducing it.

CERTAIN ALLIED SIMPLE PHENOMENA.

1. If a piece of wire gauze is placed on another with the wires nearly parallel, the well-known water lines invariably come out, oftentimes, if one piece of gauze is regularly or geometrically crumpled or dimpled, showing beautiful patterns. The explanation of this is at hand; the upper meshes being nearer the eye subtend a larger angle, and when both are projected on the same plane, two scales result, one a little larger than the other. Hence, similar to the case of the vernier or the analogous case of

musical beats, there is a crowding of the lines in some parts of the field, alternating with a paucity in intermediate parts, if both gratings be uniform, plane and alike. If the drift of the wires in the two gratings be in slightly different directions, the interlacing is dense in the former case and light in the latter, with a diagonal trend. If the gratings be imperfect or not plane, the zones of light and shade must obviously be curved. Even with parallel and equal systems in the same plane, water line effects may be produced, since there is less darkness in the loci where lines cross than where they are distinct.

WHAT ARE THE GENERAL PHENOMENA?

2. This is all simple enough; if, however, the two gratings are placed at a distance apart along an axis, and the first illuminated by strong diffuse light, the second will project a real image of the former grating at definite points on the axis, almost as if it were a zone plate. When these images are looked at by the eye in the proper position, they appear as magnifications of the first grating, oftentimes enormously large the size increasing with the distance of the focal plane from the projecting grating. If the eye be moved along the axis the images vanish rapidly to infinity on the nearer side and more gradually to zero on the farther side. Distant foci are apt to show heavy blue lines on a red ground, and *vice versa*. The indefiniteness of focus when viewed by the normal eye is due to its power of accommodation, and the size is an illusion; for the eye is adjusted for an infinite distance and locates the image of unknown position there. The eye unaided is therefore not well adapted for observations of this character. If, however, one throws the eye out of range with a reading glass of, say, 10 cm. focal distance held close to it, the variability of focal distance is practically wiped out, and the positions of the images may now be charted satisfactorily.

Some years ago, while looking through an ordinary door screen at the Venetian blinds on the opposite side of the street, I noticed that the zones of light and shade were remarkably distinct when viewed by the naked eye (which in my case is nearsighted), but that they all but vanished or were so faint as not to be an annoyance when viewed through spectacles. This observation is general: If the normal eye is put out of proper function by looking through strong convex or strong concave glasses, in either case the shadow zones at the proper distance from the screen become painfully pronounced. They disappear as the eye is properly equipped, naturally or otherwise, for long range vision. It seems probable that this principle (to which I shall return in § 5) could be used practically in fitting the eye with the proper glasses.

For the present purposes therefore either a convex or a concave lens will be needed by the normal eye to fix the proper focal planes of the grating; but as the plane for the convex lens is in front of the eye, this is the more serviceable. Direct projection is only possible in a darkened room and at the strongest focus, supposing that diffuse daylight illuminates the first grating. With sunlight all the real foci may be projected, but the use of sunlight (at the outset) slightly alters the conditions. Foci may also be found by the telescope directed along the axis; though furnishing admirable qualitative results, this is the least accurate of the methods and useful only for finding virtual foci in the cases discussed below, § 5.

Thus the following simple arrangement is suggested for measurement. Along the axis LL' there is placed the ground glass screen C, and the wire gauze* grating A just in front of it. At a distance, x, from A the

*Ordinary door screen wire gauze, say 6 inches high and 12 inches wide, in a wooden frame, answers all purposes.

second grating, B, is adjusted with the wires parallel to A; and at a distance, y, from the latter is the focal plane S, visible to the eye behind the lens (or in the distant correspondingly focused telescope, looking along $L'L$ in Fig. 2, as will be explained below).

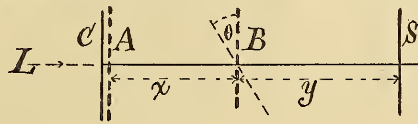


Fig. 1.

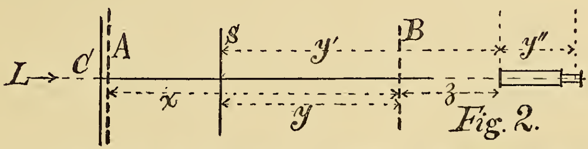


Fig. 2.

It will be convenient to call the grating space at A, a; the space at B, b; and the space of the image at S, s, all being parallel. Then the experimental results of Table 1,

TABLE 1.—EXAMPLE OF FOCAL PLANES FOR GRATINGS WITH EQUAL MESHES. $a = b = .214$ CM. AND WIRES .030 CM. IN DIAMETER, LENS FOCUS 15 CM. $a = b$.

$x =$	100	200	300	400	cm.
$y =$	125 215 —	105 225 —	155 315 615	201 410 —	cm.
Ratio, $y/x =$	1 2 —	$\frac{1}{2}$ 1 —	$\frac{1}{2}$ 1 2	$\frac{1}{2}$ 1 —	

TABLE 2.—EXAMPLE OF FOCAL PLANES FOR GRATINGS WITH UNEQUAL MESHES. MESH OF A, .214 CM., OF B, .033 CM., SO THAT $a/b = 6.5$.

$x =$	300	400	cm.
$y =$	35 75 135	65 145	cm.
$y/x =$	1 2 4	1 2 —	

in which relations of x and y for the case of $a = b$ have been inserted as an example of many similar data, will be intelligible at once.

Naturally these results are crude, but as their import is unmistakable, it is not necessary to push the experiment further. The first definite result derived from them is this, that the focal planes are distributed along the axis at distances $\frac{1}{2}$, 1, 2, etc., multiples and submultiples of the distance of the gratings apart, when the two gratings are identical, or $a = b$. The size of the images is usually directly as the distance y from grating B, and if for $a = b$, $x = y$, then $a = b = s$, or image and object are equally large. Remote focal planes are apt to be diffuse and colored nearly uniformly red and blue in alternate bands. Hence the number of foci accessible in this way is not large.

If the meshes are unequal, the focal planes are still apt to be distributed at distances varying as 1, 2, 4, etc., along the axis. Corresponding distances, y, are smaller relative to x if the projecting grating is finer. The law of distribution is not easily worked out in this way, however, because it is difficult to obtain gratings of different meshes but of the same diameter of wire. Neither is it safe to infer the size of image from these experiments. The problem must be attacked in another way.

3. Since the distances x and y are large (2-10 meters), it will be possible to obtain gratings of different fineness (effective horizontal distance of wires apart) by merely *rotating* either grating on an axis parallel to the wires. Since the focal planes have now been shown to be real, it is expedient to project the whole phenomenon with sunlight, and if parallel rays are not wanted a ground glass screen or better, a screen of scratched mica which is more translucent, may be interposed at C in Fig. 1, in front of the first grating, A. Thus if L be the direction of sunlight and θ the angle of rotation of either grating, the figure meets the present case. If A be left normal and B rotated, results are obtained for the case where the projecting meshes are smaller horizontally than those projected. If B be left normal and A rotated, the projected meshes are the smaller. For any angle θ of either A or B, the grating B and screen S may be moved along the axis to locate the other focal planes for the same mesh ratio. With the proper angle θ images may be focused for any distance y relative to x.

TABLE 3.—DATA FOR A FINER PROJECTING MESH (B ROTATED). $x = 200$ cm. $a = 1$.

y	θ	Appr. $\cos\theta$	s Image.	Remarks.	Symbol in chart.
100	0°	1	.5	bk. and wh.	Fig. 3—a
	49°	$\frac{2}{3}$	.5	"	" 7—β
	71°	$\frac{1}{3}$	.5	"	" 5—γ
200	0°	1	1.0	red and bl.	" 3—δ
	41°	$\frac{3}{4}$	.5	bk. and wh.	" 8—ε
	61°	$\frac{1}{2}$	1.0	red and bl.	" 4—η
	78°	$\frac{1}{4}$	.5	strong.	" 6—ζ
300	52°	$\frac{3}{5}$	1.5	"	" 8—strained
	75°	$\frac{3}{10}$	.75	br. and wh.	" 8— "
400	47°	$\frac{2}{3}$	2.0	"	" 7—μ
	74°	$\frac{1}{3}$	1.0	"	" 5—ν
600	42°	$\frac{3}{4}$	3.0	strong.	" 8—ξ
	70°	$\frac{3}{8}$	1.5	"	" 8—strained
700	—	—	3.5	"	————
			1.75	"	

At long ranges (500 cm. and more) the white shows faint interference fringes usually with a pink center. At 7 meters, when the ground glass screen is interposed in front of the first grating, A, the effect is a remarkably clear diffraction pattern fully two feet square or more, consisting of narrow, strong, black lines on a dull white ground. When the grating space of B is reduced to $\frac{1}{2}$ by rotating it, very fine lines fainter but very clear show on the same ground. For other mesh-ratios the field is blank, and sharp adjustment of θ is necessary. Diffuse, non-parallel light, therefore, is equally active, and being free from the intense but circumscribed glare of full sunlight, gives more striking results. Moreover, the same figures as above show through the dull mica screen for all the distances noted in the table.

Special attention may be called to the fact that the figure is still distinct even at a distance of 30 meters between the image S and the projecting grating B.

The results of the following table were obtained by keeping grating B normal and rotating A.

TABLE 4.—DATA FOR A COARSER PROJECTING MESH (A ROTATED). $x = 200$. $b = 1$.

y	θ	Appr. $\cos\theta$	s mage.	Remarks.	Symbol in chart.
200	48	$\frac{2}{3}$	1.50	Strong.	Fig. 7—μ
	60	$\frac{1}{2}$	.50	"	" 4—η
400	42	$\frac{3}{4}$	1.50	"	" 8—prol. bk.
	71	$\frac{1}{3}$	.30	"	" 5—ν'

As the obliquity of A is increased the focal plane frequently does not sharply vanish, the image merely becoming smaller. Because of this indefiniteness of smaller images further measurement was not attempted. It will be seen that the angles θ for the same y do not correspond to the preceding table, as was directly proved by exchanging the gratings. This is the important datum of the new series of observations, and makes it needless to adduce a greater number.

SCHEME FOR THE PROJECTION OF ONE GRATING BY ANOTHER.

4. In order to interpret these results it will be expedient to introduce a simple

hypothesis, of a kind which in the sequel may be modified to meet the true case. I shall proceed, therefore, to trace what may be temporarily called the effective planes of shadow in diffuse light. In other words, planes are to be passed between the two gratings through their consecutive wires and the loci of intersection determined. If the wires are vertical the result may be mapped out by drawing the traces of the two planes in question on a horizontal plane, and the object would be gained by solving a few straightforward problems in the modern geometry of pencils of rays. It will greatly facilitate inspection, however, if some of the chief cases which have been considered are drawn out in plan. This has been done in Figs. 3–8, which will be found additionally useful in the physical questions of the next section. A and B show the positions of the gratings and S, S', etc., are the successive positions of the focal plane or screen. Grating spaces and image spaces are denoted by a, b, and s, respectively. Reference planes designated by Greek letters will be presently referred to. Wherever lines mass in a single point, there one may look for a deficiency of light coming to an observer behind both gratings. Corresponding groups of intersections thus determine a focal plane.

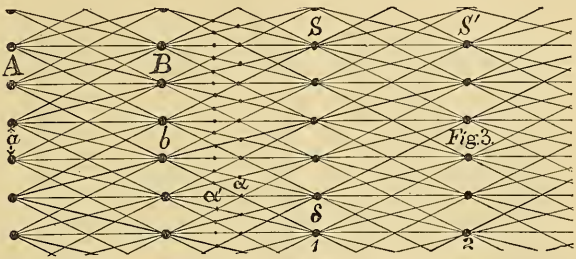


Fig. 3.

To begin with Fig. 3, in which $a = b$ or the two paralleled wire gratings are identical, the diagram is seen at once to reproduce the results of Table 1. At relatively remote distances the diverging planes tend to pass out of the field, and the images must therefore weaken for this reason alone. Table 3 describes the images α and δ, the latter colored; the focal plane α' with $s = \frac{1}{3}$ is also sharp. Following S, the planes S', S'', etc., did not appear distinctly enough to be recorded.

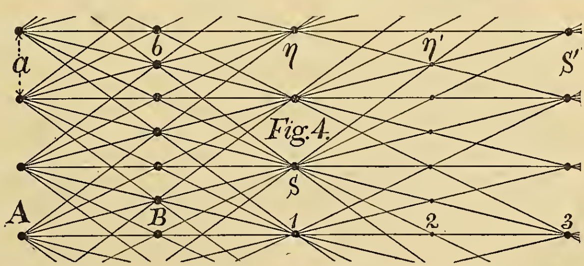
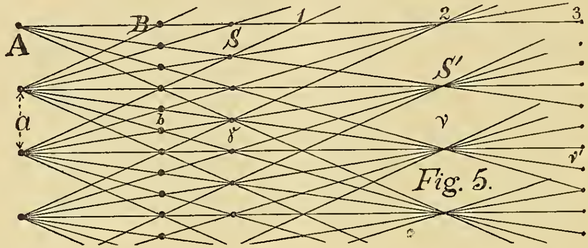


Fig. 4.

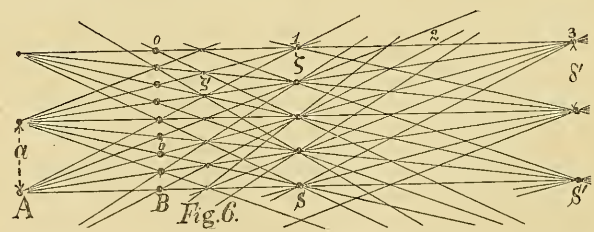
The figure shows, moreover, that between A and B there should be virtual focal planes, and these must also be discoverable to the left of A. That such actually occur will be shown below, § 5, by the telescope method. The absence of S', S'', etc., will not appear surprising, since the distance AB is two meters and shadows become diffuse. It is rather surprising that images properly produced can be obtained at over 30 meters from the projecting grating.



In Fig. 4 the meshes of B are half as large as A. Table 3 shows at η that the plane S comes out strongly and colored. S' was not found nor were the other images striking. Virtual foci are here also suggested. Table 4 indicates that if B be the first grating and S the second (larger) the focal plane η' is sharply traced.

In Fig. 5 the grating spaces are as $\frac{1}{3}$. Table 3 shows that the planes S and S' are both pronounced (marked γ and ν). According to Table 4, if B is the first grating and S' the second, the focal plane ν' will appear.

In Fig. 6, with the space ratio $\frac{1}{4}$, the image ζ is strong; the image ζ' was also found; but with these cases of high inclination θ, the images are confused and focal planes are apt to be continuous. Thus an image may be found at S', but not sharply in position. In general a contracted diagram is liable to exceptions to be explained below.



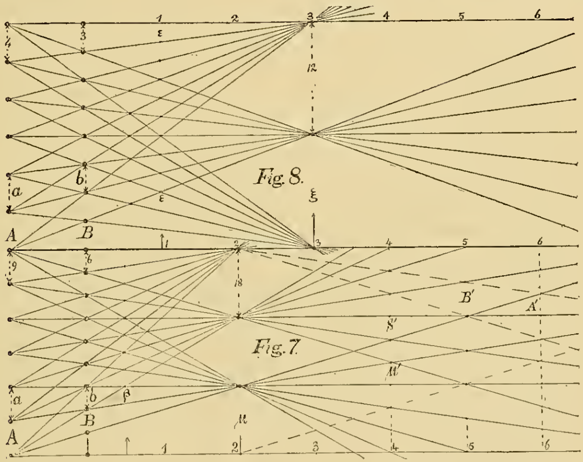
In the preceding cases the original grating space is reproduced, as, for instance, at S' in Fig. 6, when, if $x = 1$, $x + y = a/b$. The figures are symmetrical with respect to the strongest focal plane (ζ in Fig. 6, for instance). The original grating space is reduced in the image or at most equal to it. There is no magnification.

In the following cases the ratio a/b is not a whole number, and the image may therefore be magnified to an extent which is the least common multiple of a and b. Moreover, $s/a = y/x$, so that the strong image is usually remote. The projected grating is here taken as the larger, $a > b$. If $a < b$ the corresponding image space will be $s' = b(1 + (x/\overline{x + y})(\overline{2a - b}/b))$.

In Fig. 7 the ratio a/b is $3/2$. Table 3 shows the focal planes β and μ to be pronounced. The magnification at μ is 2, with strong brown lines on a white ground which contains faint traces of a pinkish diffraction band in the middle.

the light areas which are alternately white and colored reddish.

The final case to be exhibited in detail is Fig. 8, where $a/b = 4/3$. The focal planes ϵ and ξ are marked phenomena, the latter at the long distance of 6 meters from B, strong and coarse as usual. With the mica screen clean cut dark bands .2 cm. broad and .7 cm. apart, cover an area of a square foot. If B is the projecting and A the projected grating ($a/b = 3/4$, light re-



If the ratio a/b is $2/3$, A' and B' may represent the positions of the grating, the light retrogressing, so that S' is the corresponding focal plane. It is marked μ' in Table 4, where moreover μ is again reproduced as the second focal plane of this series. The coarse images for this and succeeding cases of long distance (6-10, even 30 meters), are a striking feature. The phenomenon becomes fainter but otherwise more remarkable and much larger if the ground glass or, better, the mica screen is placed before the first grating. The diffraction character then becomes manifest in

trogressing), Table 4 shows the focal plane at 4 meters well marked, and found from Fig. 8 by prolonging the lines backwards, in the direction BA.

The other cases of Tables 3 and 4 are found by subjecting Figs. 7 and 8 to a homogeneous strain, with the principal strains in the horizontal and vertical directions. Similarly, 7 would follow from 8 or from the above figures. Focal planes corresponding to S are usually well shown.

As a rule, therefore, the diagrams are a convenient means of predicting the relations of size and distance of the images.

They do not account for the accompanying color which is a not infrequent occurrence ; and they predict more focal planes than are easily found. The latter discrepancy might be ascribed to the imperfect gratings (wire gauze), or to lack of intensity taken as proportional to the number of lines which cross at a point in the diagrams. It would merely have been confusing to record other than the strong cases. The diagrams fail altogether to suggest how a thin wire is to cast a shadow of the order of 10–30 meters in length, even in diffuse light. It is in this respect that the explanation will have to be supplemented. In the meantime, however, it seems worth while to test the position of the virtual foci between *AB* and beyond *B*.

5. For this purpose it is convenient to place the gratings far apart and observe with a telescope as shown in Fig. 2. If f be the focal distance of the objective, and y'' the reduced distance of the conjugate focus, corresponding to the virtual focal plane S at a focal distance y', we may write $1/y' + 1/y'' = 1/f$. With y' computed in this way, $y = y' - z$, where z is the distance between the objective of the telescope and the grating B; and y, as usual, the distance between this and the image. The distance x may be measured or found by the same method.

This experiment gives excellent results for the number and relative size of the successive images between A and B. It is a crude method of finding the distances y, sufficing, however, to pick out their position in a series. If A be the clapboarding of a distant house and, B an ordinary window screen through which A, distant about 300 feet, is observed, the conditions for many virtual foci will be realized. Table 5 gives an example of results of this kind.

The table shows that the limits of y are pretty well given, the visible foci should all lie near B as found. All the focal planes observed are predicted by a diagram of intersecting pencils of rays of the kind above exhibited, as indicated by the third and fourth columns of the table. Nevertheless,

TABLE 5.—VIRTUAL FOCI BETWEEN THE GRATINGS. $x = 10{,}000$ CM. $z = 274$ CM. GRATING SPACES, $a = 10.7$, $b = 22$ CM.

Focus. No.	y'', reduced.	y, predicted.	y, observed.		Size.
Screen	37.0	0	0	(0)	——
2	35.8	63	56	(1)	small.
3	35.5	125	137	(2)	larger.
—	—	188*	—	—	——
4	34.8	250	272	(4)	largest.
—	—	313	—	—	——
—	—	375*	—	—	——
—	—	437	—	—	——
5	34.1	500	532	(8)	smaller.
—	—	563*	—	—	——
—	—	625	—	—	——
—	—	688	—	—	——
6	33.7	750*	756	(10)	much smaller.
Clap boards	32.8	—	10,000	—	——

many images are predicted which do not occur; and whereas the predicted images should be all of nearly a size, practically of the same grating space as B, the images found are all much smaller. They increase to a maximum and then diminish again in the direction BA, with the largest not more than $\frac{1}{2}$ of b. Possibly the presence of two or more focal planes in the telescope at once would account for the discrepancy of size and number, but the planes marked * which should be strong do not appear specially so in the experiment. In general, therefore, the diagrams give a good outline of the phenomena, but fail in the particulars. One may note that the foci found are in a distance ratio of 0, 1, 2, 4, 8, 10, which is liable to be more than a coincidence.

Another class of virtual foci consists of images not lying between the gratings, but on one side of both when looked at from the other side. This implies the same method of telescopic observation : obviously the cases of Figs. 3–8 can all be found as virtual images by a telescope in front of A, looking from A to B. In such a case A may be moved quite up to the object glass or drawn on it. Knowing the position of the images, it is possible that such an arrangement might be used in measuring distances, A being for this purpose taken suitably greater than B.

Here I may revert to the observations with and without spectacles instanced above. If the eye is so circumstanced as to focusing power as to be able to see grating A in the distance through grating B distinctly, then the shadow bands will be out of focus and faint. If, however, a near-sighted eye or one made abnormal by convex or in a second case by concave lenses, grating A is quite out of the range of vision. The eye will then find and fix upon one of the focal planes, virtual or real, due to the projection of A by B. If there be not too much stray light, the shadow bands in such a case are painfully obtrusive.

LONG SHADOWS CAST BY THIN WIRES IN NON-PARALLEL LIGHT.

6. It is finally necessary to explain the long lines of shadow assumed tentatively in the above hypothesis. Even in sunlight a filamentary wire will not cast an effective shadow further than 5 or 10 inches; the shadows here encountered may be 100 feet in length.

Clearly the phenomenon is one of diffraction, and it will be expedient to recall the fundamental case of a single slit and a single edge. The pattern is well known, consisting outside of the geometrical shadow of a very bright and then very dark band, followed by colored alternations of light and shade more cramped and much less distinct and intense. Within the shadow the light sinks gradually into darkness.

Suppose the slit to be displaced laterally to the left a small distance; the whole diffraction pattern will then move toward the right over the same distance if $x = y$, and for other distance ratios, proportionally. Now suppose that both slit actions occur simultaneously. The feature of the diagram will be the two maxima of light enclosing between them a shadow band without color, which is a compound of the darkness within the geometrical shadow for the first slit, now limited on the right side also by the maximum of the second slit and its external dark band. *The effect therefore is the same as if the bar between the two slits were projected.* For $x = y$ the distance between the light maxima will be the same as the distance between the slits otherwise in proportion to relative distance. If the slits are finer the phenomenon is darker and sharper; if coarser, brighter and more vague. If the slits move closer together the bands move closer proportionally. Color is rarely apparent.

It follows from the preceding that with 3 slits and an edge, 3 maxima of light and 2 dark bands without color will appear; with 4 slits, 4 maxima and 3 shadows, etc. The whole phenomenon may be regarded as crowded into the geometrical shadow of the first slit. Hence if the slits increase in number the number of bands will soon reach a limit as more and more light falls inside the edge of the shadow in question. With a coarse grating (rods and spaces say .2 cm.) but 5 shadow bands may appear for an indefinite number of spaces. In general the diffraction pattern covers a certain area; if the slits move closer together there will be more and finer bands visible; if they move farther apart, fewer. With an edge just in front of a telescope or on the objective and light nearly screened off, an indefinite number of lines may be seen on looking at a distant white surface through grating A. From the distance of A from the objective (.1 to several meters) and the size of image and object the magnification of the telescope may be inferred.

7. With the case of an edge and multiple

slit sufficiently disposed of, the case of a single wire and multiple slit is not far to seek. There will be a series of light and shade bands for each edge of the wire, and the two series will eventually run through each other. A single slit has within the geometrical shadow the well known brownish band, finely fluted and broad for a thick wire, coarsely fluted and narrow for a thin wire. With 2 slits there will be 2 shadow bands with a maximum of light between for a fine wire, or 3 bands with an intensely dark one in the middle for a stout wire (say 3 mm.). With 3 slits and a fine wire 3 shadow bands appear at long ranges ($y/x = 1/3$), more at short distances. With a coarse wire 4 at long ranges with the two internal bands intense, 5 or more at short ranges, etc. It follows eventually that with a *multiple* slit and wire the diffraction patterns may be looked upon as compounds of the light and shade bands of *each edge*. At $x = 2$, $y = .5$ meters, a blur usually appears for the thin wire, sharp fine lines edging a broad central shadow for the thick wire. This continues up to 2 meters in the latter case; but with the thin wire with y between 1 and 2 meters, there are apt to be colored blue and red bands of a very complicated pattern. Beyond two meters the figure is in all cases again simply white and black, with the former or the latter wider conformably with the structure of grating A, supposed to be at 2 meters from B. Size of rod is without influence here. With the thick wire the central ever-narrowing shadow may be visible beyond 2 meters, and as it apparently thrusts the bands apart the figure is relatively broad. In so far as the edge effect predominates and overlapping is obscured in the middle, the bands appear in focus at all distances.

8. From these results to the actual case of the grating is an easy step. Grating A furnishes the multiple slits, about 5–10 of which are effective for every wire of grating B. Each of these has its own series (about 8 in the above case) of shadow bands, all identical in form. When for any position on the axis the shadow bands of all the wires of B coincide, there will be a focal plane at that point and B will project an image of A. At other points there will be no image, for patterns overlap irregularly, light falling on shade and producing more or less uniform illumination. Figs. 3–8 show the conditions to be such that many band series must overlap, and hence the greater definition of focus.

At close ranges, therefore, both the width of the wire (in relation to the independent shadow bands of each of its edges) and the distance apart of the wires (in relation to the above Figs. 3–8) must be of proper value to produce coincident effects. At long ranges coincidences depend more on the diagrams.

From another point of view we may consider the band series of the right and left hand edges of the wire of the grating independently. The former will be brought to focus at those points of the axis where the successive images of corresponding edges overlap. The latter equally so. The two images so formed, and corresponding respectively to the two edges of all the wires of B, will not blend in a compound image, unless the images coincide. If the separate edge images are apparently displaced relatively to each other, *i. e.*, if there is appreciable non-coincidence of shadow bands, there will be no focal plane even if the images of the separate edges are perfect. Hence there is an adequate account given of the absence of focal planes predicted by the above constructions. Again, just as there may be color effects for a single wire at certain distances, so for the wires conjointly there will be color phenomena between the images of all corresponding edges. Finally, an inkling is given as to why focal planes which from diagrams 3–8 one would expect to be strong, do not so appear; and *vice versa*. Images which would be strong for the right and left edges separately need not be so when the former are superimposed on the latter.

With these remarks I believe to have given a sufficient account of these interesting diffractions. I began the work since in all my reading in physics I had never seen a reference to these ubiquitous phenomena, and I hoped with the present paper to furnish at least one contribution of known whereabouts. In the course of the work I found much greater subtlety than I was prepared for, and some of the cases given are available for more rigorous treatment elsewhere.

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THE CROSSLEY REFLECTOR OF THE LICK OBSERVATORY.

THE leading article in the June number of *The Astrophysical Journal* has the above title and was written by Professor Keeler. It is a very full account of the instrument and of the work accomplished with this telescope since its installation on Mt. Hamilton. I am very glad to comply with the request of the editor to furnish an abstract for SCIENCE.

The frontispiece of the number is an excellent heliogravure plate of the 'Trifid' nebula in Sagittarius, from a negative made with the Crossley reflector. In this connection it ought to be said that no known method of reproduction gives all the detail to be seen on the original negatives of such subjects. There are also halftone illustrations, from photographs, of the details of the telescope and its observatory.

This telescope was made by Dr. A. A. Common, of London, in 1879, and used by him until 1885, when he decided to build one of 5 feet aperture. He then sold the 3-foot instrument to Edward Crossley, Esq., of Halifax, England. For the construction of the instrument and for photographs obtained with it, Dr. Common was awarded the gold medal of the Royal Astronomical Society in 1884.

Mr. Crossley built a very complete observatory and dome for the telescope and used it for a number of years. The climate of Halifax was not adapted to the use of reflectors, however, and in 1895, at the request of Professor Holden, then director of the Lick Observatory, Mr. Crossley presented the telescope and its dome to this institution. The expenses incurred in transporting it from England and in erecting a suitable building on Mt. Hamilton were borne by friends of the Lick Observatory, principally residents of California. It was mounted here the same year. Its dome is situated on a spur of the mountain some 350 yards to the south of the main observatory and about 150 feet lower. The building contains, in addition to the dome and vestibule, a photographic darkroom, a study, a room for apparatus and storage, and a room for the hydraulic machinery which was used in England to revolve the dome. The present site is such that the hydraulic system which is used for the large refractor is not available for the Crossley reflector. The dome is turned by hand by means of an endless rope and a set of gears working in a cast-iron rack bolted to the inside of the sole plate of the dome. The dome is covered with sheet-iron, the framework being of iron girders. It is of the usual form, with a shutter in two parts which are rolled to each side, exposing a slit six feet wide. The slit extends well beyond the zenith. From the inside of the dome is swung a system of platforms around the telescope for the observer to stand upon. The cylindrical walls upon which the dome rests are double, 36¼ feet inside diameter. The dome itself is 38 feet 9 inches in diameter. The lower half of the observing slit was fitted with a screen of tarpaulin by Professor Keeler, which proved very useful against the winds which are so prevalent on Mt. Hamilton.

The telescope and its mounting are very completely described and figured by Dr. Common in Vol. 46 of the *Memoirs* of the Royal Astronomical Society. The telescope was designed especially for photographic work, in which it is very desirable to continue an exposure uninterrupted, across the meridian. This cannot be done in the usual form of mounting where the declination axis is attached to the middle of the tube of the telescope and to one end of a short polar axis. Dr. Common obviated this difficulty by placing the declination axis at the extreme lower end of the telescope tube, the axis of the telescope always being in the same meridian plane as the polar axis. The large mirror is *above* the declination axis, and hence requires to be counterbalanced. This counterbalancing of mirror and tube is effected by placing slabs of lead in two boxes which extend a short distance beyond the declination axis. Professor Keeler points out that the construction adopted by Dr. Common for his 5-foot reflector is a great improvement. In the latter instrument the tube is swung near its lower end between two large ears attached to the polar axis, the pivots forming the declination axis. The mirror is placed at the extreme end of the tube and thus acts as a counterbalance.

The construction of the mounting limits observations to 25° south declination. In London, for the latitude of which the mounting was constructed, this meant a zenith distance of 77° on the meridian, but at Mt. Hamilton it is only 62°. In our more southern latitude a considerable region is thus unfortunately out of reach of the telescope.

From his experience with the Crossley reflector, Professor Keeler came to the conclusion that the definition in the case of a reflector, as well as a refractor, depends almost wholly on external conditions, and that large masses of metal near the mirror have little effect, at least where the range of temperature is as small as at Mt. Hamilton.

The telescope is used as a Newtonian. It is provided with two large mirrors, each three feet in aperture, and of 17 feet 6.1 inches focal length. These mirrors were made by Mr. Calver. The one in use at present (mirror A) was refigured by Sir Howard Grubb, and is practically perfect for photographic work. It may be added that this mirror has so far been used with the same coating of silver which it had when received from England. Mirror B has not been used at Mt. Hamilton.

The diagonal mirror is round, its diameter being 8.9 inches. Its distance inside the focus is 29 inches.

The field of view after reflection is, therefore, elliptical. Its mounting is such, however, as to cut off an almost circular section of rays from the large mirror.

The tube of the telescope is a square framework of iron tubes braced by diagonal rods and is provided with curtains of black cloth to close the tube in. Professor Keeler found that any fogging of the plate was due to diffused skylight and the curtains have therefore been dispensed with. The outer end can be rotated about the axis of the telescope to bring the eyepiece into as comfortable a position as possible. This section carries the diagonal mirror and the eye end. The latter has the customary arrangement for focusing and is made to take the short tubes, one of which is arranged for visual and the other for photographic work. The photographic slide contains, in addition to the double motion device, an adjustable slide carrying an eye-piece with cross wires for guiding. This is placed very close to the plate-holder slide and clamped to it.

The image of a star is kept bisected by turning the proper screws attached to the movable frame.

Upon taking charge of the Lick Observatory in June, 1898, Professor Keeler decided to devote his own observing time to the Crossley reflector, notwithstanding that his previous experience had all been with refractors. Upon making a careful examination of the instrument, he found that a number of changes would be necessary before satisfactory results could be expected. Some of these were required on account of the change in latitude and the different climatic conditions existing at Mt. Hamilton. The brick pier upon which the telescope rested was found to be too high for the greatest convenience and usefulness and was lowered two feet. The polar axis was found to work hard, the plan of mercury flotation not being successful and the construction being such that the friction was increased in this lower latitude. This caused the driving clock to run irregularly, and a more powerful one was built at the observatory from designs by Professor Hussey. A further cause of irregularity was found in one of the wheels of the differential gearing for giving slow motion in right ascension. As long exposure photographs near the pole required a considerable degree of accuracy in the position of the polar axis, some time was spent in devising methods for adjusting a telescope of this design. The methods used for a telescope of the ordinary construction do not suffice. One very promising plan was to secure trails of the stars near the pole on the same plate in two positions of the telescope 180° apart. Consistent results were not obtained, however, owing to the instability of the large mirror. The axis was finally adjusted by using a long finder for observations of Polaris in the usual way, a watch telescope being fastened to the mounting in such a way that an object on the southern horizon could be observed during the process of shifting the iron pier.

The resolving power of the telescope was tested by visual observations of close double stars, with the result that stars of about the 8th magnitude and of nearly equal brightness could be separated with a magnifying power of 620, if as much as 0″.3 apart. Stars of 5th magnitude and this distance could not be seen double owing to the increased amount of light. In connection with these observations Professor Keeler remarks: "Although the theoretical limit of resolution for a three-foot aperture is not reached in these observations, I do not think the mirror can do any better."

It is, however, in photographic work that the greatest field for the Crossley reflector appears to lie, and it is largely with respect to this line of work that any changes have been considered.

The ratio of aperture to focal length is so large in the instrument (a little greater than 1 to 6) that the field of view over which the star images are sufficiently free from distortion is only about 16′, or one inch, in diameter. The photographic equipment was designed to use plates $3\frac{1}{4}$x$4\frac{1}{4}$ inches in size. These are sufficiently large, for even with this size the star images show decided wings near the edges of the plates.

Several minor changes and improvements were made in the eye-end apparatus. Metal plate-holders were substituted for the wooden ones, as the latter could not be depended upon to keep their positions throughout the long exposures. Clamping screws were added to hold the plate-holder firmly in place. Spider threads were substituted for the coarse wires in the guiding eyepiece, and a system of mirrors added to illuminate the declination thread. A small electric lamp is used to illuminate the wires, current being supplied from the storage battery at the main observatory.

A piece of ruby glass between the lamp and wires prevents fogging of the plate.

As designed, the wires of the guiding eye-piece were in the same plane as the photographic plate, but as they were some three inches from the optical axis of the telescope a star's image was a crescent, and therefore unsuitable for purposes of accurate guiding. Outside this plane the star image, as seen in the guiding eye-piece, changes to an arrow-head whose point is directed to the optical axis of the telescope. As it was found that the focus of the telescope changed during long exposures, an image of the guiding star which was sensitive to changes of focus was highly desirable. Professor Keeler found that between the crescent and the arrow-head there was an image formed by the intersection, at an acute angle, of two well defined caustic curves in the aberration pattern. The intersection of these caustics offers a very satisfactory image on which to guide, and at the same time is very sensitive to changes of focus. The relation of the plane of the photographic plate and of the guiding threads was so altered that when the former was adjusted to accurate focus, by means of a high power positive eye-piece, a star's image assumed this particular form in the guiding eye-piece. By noting carefully at the commencement of the exposure the form of the star's image, the focus could be corrected by means of the focusing screw as changes were seen to occur. Photographs of four hours' duration were secured on which the star disks near the center of the plate were almost perfectly round, the smallest disks being from 2″ to 3″ in diameter.

In compensating for the variations of the motion of the telescope from that of the stars by moving the plate-holder, there is a limit which Professor Keeler has pointed out, to the amount which the plate-holder may be moved without causing distortions in some of the star images. This distortion arises from the fact that the motion of the plate-holder is in a straight line, while the stars describe small circles about the pole. Hence compensation by such a method of guiding is exact at the equator only. The amount which the plate-holder may be moved without causing an appreciable elongation of the star's image may be found from the formula,

$$d = \frac{e \cos \delta_1}{\cos \delta_2 - \cos \delta_1}$$

in which d is the displacement of the plate-holder; e the amount of elongation in the star's image which becomes perceptible; δ_1 the declination of the guiding star, and δ_2 the declination of the star on the plate farthest from the guiding star in declination. In the Crossley reflector it was found that at a declination of 70° (where many nebulæ were to be photographed) the plate-holder could not be moved in right ascension more than 1.0 mm. without causing an elongation of the fainter star images which were farthest from the guiding eye-piece in declination, of an amount equal to their own diameters. There is also a small distortion in declination, but on the scale of the Crossley photographs it is negligible.

To prevent halation in the long exposures, the plates are backed with a coating of Carbutt's 'Columbian Backing,' which has proved very satisfactory.

One of the earliest photographs obtained by Professor Keeler was a very successful one of the great nebula in Orion. This and similar photographs pointed to the great efficiency of the instrument for showing the structure in the nebulæ, and led to the systematic photographing of all the brighter ones within reach of the telescope. This program had been about half completed by Professor Keeler before his untimely death. In the prosecution of this work, great numbers of faint nebulæ were revealed; on one plate no less than *thirty-one* new ones were found. The accurate positions of these new nebulæ are now being measured by Mr. Palmer. He finds, on the average, about *ten* new nebulæ to the plate.

Professor Keeler summarizes the conclusions to be drawn from the work so far accomplished as follows:

"1. Many thousands of unrecorded nebulæ exist in the sky. A conservative estimate places the number within reach of the Crossley reflector at about 120,000. The number of nebulæ in our catalogues is but a small fraction of this.

"2. These nebulæ exhibit all gradations of apparent size, from the great nebula in Andromeda down to an object which is hardly distinguishable from a faint star disk.

"3. Most of these nebulæ have a spiral structure.

"To these conclusions I may add another, of more restricted significance, though the evidence in favor of it is not yet complete. Among the objects which have been photographed with the Crossley telescope are most of the 'double' nebulæ figured in Sir John Herschel's catalogue (*Phil. Trans.*, 1833, Plate XV.). The actual nebulæ, as photographed, have almost no resemblance to the figures. They are, in fact, spirals, sometimes of very beautiful and complex structure; and, in any one of the nebulæ, the secondary nucleus of Herschel's figure is either a part of the spiral approaching the main nucleus in brightness, or it cannot be identified with any real part of the object. The significance of this somewhat destructive conclusion lies in the fact that these figures of Herschel have sometimes been regarded as furnishing analogies for the figures which Poincaré has deduced, from theoretical considerations, as being among the possible forms assumed by a rotating fluid mass; in other words, they have been regarded as illustrating an early stage in the development of double star systems. The actual conditions of motion in these particular nebulæ, as indicated by the photographs, are obviously very much more complicated than those considered in the theoretical discussion."

As evidence of the power of the Crossley telescope it may be noted that a very faint image of the Ring Nebula in Lyra was obtained with an exposure of thirty seconds; with an exposure of two minutes a well marked impression of the nebula is obtained and a surprisingly strong image of the central star, which is a very faint object visually in the 36-inch refractor.

In the course of the work on the nebulæ, two new asteroids have been discovered, by means of their trails, one at least of which was so faint as not to be seen with certainty with the large refractor. Observations of these asteroids were made photographically, and were found to compare very favorably in accuracy with such observations made visually with a large refractor. These results point to the great value of this instrument for finding and giving the positions of asteriods, whose places are approximately known.

One of the most promising fields for the Crossley reflector is undoubtedly that of stellar spectroscopy. Two spectrographs have been designed and built at the observatory. One is due to the generosity of Miss C. W. Bruce, and contains three prisms of 60° and one of 30°, with an aperture of two inches; the other has a single quartz prism and is intended to give measurable, though small, spectra of some special objects nearly at the limit of vision of the telescope.

From what has been said, it will be seen that a large amount of work of great importance has already been accomplished with the Crossley reflector, besides opening up new fields for future investigation.

Professor Keeler clearly recognized the

necessity for attention to the small details as an element of success. He says:

"The foregoing account of the small changes which have been made in the Crossley telescope and its accessories may appear to be unnecessarily detailed, yet these small changes have greatly increased the practical efficiency of the instrument, and therefore, small as they are, they are important. Particularly with an instrument of this character, the difference between poor and good results lies in the observance of just such small details as I have described."

C. D. Perrine.
Lick Observatory,
University of California,
September 23, 1900.

ADDRESS OF THE PRESIDENT OF THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.

THE MODERN SYSTEM OF TEACHING PRACTICAL INORGANIC CHEMISTRY AND ITS DEVELOPMENT.

In choosing for the subject of my Address to-day the development of the teaching of practical inorganic chemistry I do so, not only on account of the great importance of the subject, but also because it does not appear that this matter has been brought before this Section, in the President's Address at all events, during the last few years.

In dealing generally with the subject of the teaching of chemistry as a branch of science it may be well in the first place to consider the value of such teaching as a means of general education, and to turn our attention for a few minutes to the development of the teaching of science in schools.

There can be no doubt that there has been great progress in the teaching of science in schools during the last forty years, and this is very evident from the perusal of the essay, entitled 'Education: Intellectual, Moral, and Physical,' which Herbert Spencer wrote in 1859. After giving his reasons for considering the study of science of primary importance in education, Herbert Spencer continues: "While what we call civilization could never have arisen had it not been for science, science forms scarcely an appreciable element in our so-called civilized training."

From this it is apparent that science was not taught to any appreciable extent in schools at that date, though doubtless in some few schools occasional lectures were given on such scientific subjects as physiology, anatomy, astronomy and mechanics.

Herbert Spencer's pamphlet appears to have had only a very gradual effect towards the introduction of science into schemes of education. For many years chemical instruction was only given in schools at the schoolroom desk, or at the best from the lecture table, and many of the most modern of schools had no laboratories.

The first school to give any practical instruction in chemistry was apparently the City of London School, at which, in the year 1847, Mr. Hall was appointed teacher of chemistry, and there he continued to teach until 1869.* Besides the lecture theater and a room for storing apparatus, Mr. Hall's department contained a long room, or rather passage, leading into the lecture theater, and closed at each end with glass doors. In this room, which was fitted up as a laboratory, and used principally as a preparation room for the lectures, Mr. Hall performed experiments with the few boys who assisted him with his lectures. As accommodation was at that time strictly limited, he used to suggest simple experiments and

*Mr. A. T. Pollard, M.A., Head Master of the City of London School, has kindly instituted a search among the bound copies of the boys' terminal reports, and informs me that in the School form of Terminal Report a heading for Chemistry was introduced in the year 1847, the year of Mr. Hall's appointment.

encourage the boys to carry them out at home, and afterwards he himself would examine the substances they had made.

From this small beginning the teaching of chemistry in the City of London School rapidly developed, and this school now possesses laboratories which compare favorably with those of any school in the country.

The Manchester Grammar School appears to have been one of the first to teach practical chemistry. In connection with this school a small laboratory was built in 1868: this was replaced by a larger one in 1872, and the present large laboratories, under the charge of Mr. Francis Jones were opened in 1880.

Dr. Marshall Watts, who was the first science master in this school, taught practical chemistry along with the theoretical work from the commencement in 1868.

As laboratories were gradually multiplied it might be supposed that boys were given the opportunity to carry out experiments which had a close connection with their lecture-room courses. But the program of laboratory work which became all but universal was the preparation of a few gases, followed by the practice of qualitative analysis. The course adopted seems to have been largely built up on the best books of practical chemistry in use in the colleges at that time; but it was also, no doubt, largely influenced by the requirements of the syllabus of the Science and Art Department, which contained a scheme for teaching practical chemistry.* Even down to quite recent times it was in many schools still not considered essential that boys should have practical instruction in connection with lectures in chemistry.

A Report issued in 1897 by a special Committee appointed by the Technical Education Board of the London County Council adduces evidence of this from twenty-five secondary schools in London, in which there were 3,960 boys learning chemistry. Of these 1,698 boys, or 34 per cent., did no practical work whatever; 955 boys, or 24 per cent., did practical work, consisting of a certain amount of preparation of gases, together with qualitative analysis; but of these latter 743, or 77 per cent., had not reached the study of the metals in their theoretical work, so that their testing work can have been of little educational value. It was also found that in the case of 655, or 68 per cent. of the total number of boys taking practical work, the first introduction to practical chemistry was through qualitative analysis.

But some years before this Report was issued a movement had begun which was destined to have far-reaching effect. A Report 'on the best means for promoting scientific education in schools' having been presented to the Dundee Meeting of this Association in 1867, and published in 1868, a Committee of the British Association was appointed in 1887; 'for the purpose of inquiring and reporting upon the present methods of teaching chemistry.' The well-known Report which this Committee presented to the Newcastle meeting in 1889 insisted that it was worth while to teach chemistry in schools, not so much for the usefulness of the information imparted as for the special mental discipline it afforded if the scientific method of investigating nature were employed. It was argued that 'learners should be put in the attitude of discoverers, and led to make observations, experiments, and inferences for themselves.' And since there can be little progress without measurement, it was pointed out that the experimental work would necessarily be largely of a quantitative character.

* I find, on inquiry, that examinations in the Advanced Stage and Honors of Practical Chemistry were first held by the Science and Art Department in 1878, the practical examination being extended to the Elementary Stage in 1882.

Professor H. E. Armstrong, in a paper read at a conference at the Health Exhibition five years before this, had foreshadowed much that was in this Report. He also drew up a detailed scheme for 'a course of elementary instruction in physical science,' which was included in the Report of the Committee, and it cannot be doubted that this scheme and the labors of the Committee have had a very marked influence on the development of the teaching of practical chemistry in schools. That this influence has been great will be admitted when it is understood that schemes based on the recommendation of the Committee are now included in the codes for both Elementary Day Schools and Evening Continuation Schools. The recent syllabuses for elementary and advanced courses issued by the Incorporated Association of Headmasters and by the Oxford and Cambridge local board and others are evidently directly inspired by the ideas set forth by the Committee.

The department of Science and Art has also adopted some of the suggestions of the Committee, and a revised syllabus was issued by the Department in 1895, in which qualitative analysis is replaced by quantitative experiments of a simple form, and by other exercises so framed 'as to prevent answers being given by students who have obtained their information from books or oral instruction.' This was a very considerable advance, but it must be admitted that there is nothing in the syllabus which encourages, or even suggests, placing the learners in the attitude of discoverers, and this, in the opinion of the Committee of this Association, is vital if the teaching is to have educational value.

Many criticisms have been passed upon the 1889 Report. It has been said that life is much too short to allow of each individual advancing from the known to the unknown, according to scientific methods, and that even were this not so too severe a tax is made upon the powers of boys and girls. In answer to the second point it will be conceded that while it is doubtless futile to try to teach chemistry to young children, on the other hand experience has abundantly shown that the average schoolboy of fourteen or fifteen can, with much success, investigate such problems as were studied in the researches of Black and Scheele, of Priestley and Cavendish and Lavoisier, and it is quite remarkable with what interest such young students carry out this class of work.

It may be well to quote the words which Sir Michael Foster used in this connection in his admirable presidential address to this Association in 1899. He said: "The learner may be led to old truths, even the oldest, in more ways than one. He may be brought abruptly to a truth in its finished form, coming straight to it like a thief climbing over a wall; and the hurry and press of modern life tempt many to adopt this quicker way. Or he may be more slowly guided along the path by which the truth was reached by him who first laid hold of it. It is by this latter way of learning the truth, and by this alone, that the learner may hope to catch something at least of the spirit of the scientific inquirer."

I believe that in the determination of a suitable school course in experimental science this principle of historical development is a very valuable guide, although it is not laid down in the 1889 Report of the British Association.

The application of this principle will lead to the study of the solvent action of water, of crystallization, and of the separation of mixtures, of solids before the investigation of the composition of water, and also before the investigation of the phenomena of combustion. It will lead to the investigation of hydrochloric acid before chlorine, and especially to the postponement of atomic and molecular theories, chemical equations, and the laws of chemical combination, until the student has really sufficient knowledge to understand how these theories came to be necessary.

There can be no doubt that this new system of teaching chemistry in schools has been most successful. Teachers are delighted with the results which have already been obtained, and those whom I have had the opportunity of consulting, directly and indirectly, cannot speak too highly of their satisfaction at the disappearance of the old system of qualitative analysis, and the institution of the new order of things. Especially I may mention in this connection the excellent work which is being carried on under the supervision of Dr. Bevan Lean at the Friends' School in Ackworth, where the boys have attained results which are far in advance of anything which would have been thought possible a few years since.

It is, of course, obvious that if a schoolboy is made to take the attitude of a discoverer his progress may appear to be slow. But does this matter? Most boys will not become professional chemists; but if while at school a boy learns how to learn, and how to 'make knowledge'* by working out for himself a few problems, a habit of mind will be formed which will enable him in future years to look in a scientific spirit at any new problems which may face him. When school days are past the details of the preparation of hydrogen may have been forgotten; but it was really understood at the time that it could not be decided at once whether the gas was derived from the acid or from the metal, or from the water, or in part from the one and in part from the other, an attitude of scepticism and of suspended judgment will have been formed, which will continue to guard from error.

* *Cf.* Professor J. G. Macgregor in *Nature*, September, 1899.

In the new system of teaching chemistry in schools much attention must necessarily be given to weights and measurements; indeed, the work must be largely of a quantitative kind, and it is in this connection that an important note of warning has been sounded by several teachers.* They consider, very rightly, that it is important to point out clearly to the scholar that science does not consist of measurement, but that measurement is only a tool in the hand of the inquirer, and that when once sufficient skill has been developed in its use it should be employed only with a distinct object. Measurements should, in fact, be made only in reference to some actual problem which appears to be really worth solving, not in the accumulation of aimless details.

And, of course, all research carried out must be genuine and not sham, and all assumption of the 'obvious' must be most carefully guarded against. But the young scholar must, at the same time, not forget that although the scientific method is necessary to enable him to arrive at a result, in real life it is the answer to the problem which is of the most importance. †

Although, then, there has been so much discussion, during the last ten years, on the subject of teaching chemistry in schools, and such steady progress has been made towards devising a really satisfactory system of teaching the subject to young boys and girls, it is certainly very remarkable that practically nothing has been said or written bearing on the training which a student who wishes to become a chemist is to undertake at the close of his school-days at the college or university in which his education is continued.

One of the most remarkable points, to my mind, in connection with the teaching of

* *Cf.* H. Picton in *The School World*, November, 1899; Bevan Lean, *ibid.*, February, 1890.

† *Cf.* Mrs. Bryant, *Special Reports on Educational Subjects*, Vol. II., p. 113.

chemistry is the fact that although the science has been advancing year by year with such unexampled rapidity, the course of training which the student goes through during his first two years at most colleges is still practically the same as it was thirty or forty years ago. Then, as now, after preparing a few of the principal gases, the student devotes the bulk of his first year to qualitative analysis in the dry and wet way, and his second year to quantitative analysis, and, although the methods employed in teaching the latter may possibly have undergone some slight modification, there is certainly no great difference between the routine of simple salt and mixture followed by quantitative analysis practiced at the present day and that which was in vogue in the days of our fathers and grandfathers.

Since, then, the present system has held the field for so long, not only in this country but also on the Continent, it is worth while considering whether it affords the best training which a student who wishes to become a chemist can undergo in the short time during which he can attend at a college or university. In considering this matter I was led in the first place to carefnlly examine old books and other records, with the object of finding out how the present system originated, and I think that valuable and interesting information bearing on the subject may be obtained from a very brief sketch of the rise and development of the present system of teaching chemistry, and especially in so far as it bears on the inclusion of qualitative analysis. Unfortunately, it is not so easy to gain a good historical acquaintauce with the matter as I first imagined would be the case, and this is due in a large measure to the fact that so few of the laboratories which took an active part in the development of the present system of chemical training have left any record of the methods which they employed. In this connection I may, perhaps, be allowed to suggest that it would be a valuable help to the future historian if all prominent teachers of chemistry would leave behind them a brief record of the system of teaching adopted in their laboratories, showing the changes which they had instituted, the object of these changes and the results which followed their adoption.

There is no doubt that the progress of practical chemistry went largely hand in hand with the progress of theoretical chemistry, for as the latter gradually developed, so the necessity for the determination of the composition, first of the best known, and then of the rarer minerals and other substances, became more and more marked.

The analytical examination of substances in the dry way was employed in very early times in connection with metallurgical operations, and especially in the determination of the presence of valuable constituents in samples of minerals. Cupellation was used by the Greeks in the separation of gold and silver from their ores and in the purification of these metals. Geber knew that the addition of niter to the ore facilitated the separation of gold and silver, and subsequently Glauber (1604–1668) called attention to the fact that many commoner metals could easily be separated from their ores with the aid of niter.

But it was not till the eighteenth century that any marked progress was made in analysis in the dry way, and the progress which then became rapid was undoubtedly due to the discovery of the blowpipe, and to the introduction of its use into analytical operations. The blowpipe is mentioned for the first time in 1660, in the transactions of the Accademia del Cimento of Florence, but the first to recommend its use in chemical operations was Johann Andreas Cramer in 1739. The progress of blowpipe analysis was largely due to Gahn (1745–1818), who spent much time in perfecting its use in the examination of minerals, and it was he who first used platinum wire and cobalt solution in connection with blowpipe analysis. The methods employed by Gahn were further developed by his friend Berzelius (1779–1848), who gave much attention to the matter, and who with great skill and patience gradually worked out a complete scheme of blowpipe analysis, and published it in a pamphlet, entitled 'Ueber die Anwendung des Löthrohrs,' which appeared in 1820. After the publication of this work blowpipe analysis rapidly came into general use in England, France and Germany, and the scheme devised by Berzelius is essentially that employed at the present day.

Indeed, the only notable additions to the method of analysis in the dry way since the time of Berzelius are the development of flame reactions, which Bunsen worked out with such characteristic skill and ingenuity, and the introduction of the spectroscope.

The necessity for some process other than that of analysis in the dry way seems, in the first instance, to have arisen in quite early times in connection with the examination of drugs, not only on account of the necessity for discovering their constituents, but also as a means of determining whether they were adulterated. In such cases analysis in the dry way was obviously unsuitable, and experience soon showed that the only way to arrive at the desired result was to treat the substance under examination with aqueous solutions of definite substances, the first reagent apparently being a decoction of gallnuts, which is described by Pliny as being employed in detecting adulteration with green vitriol.

The progress made in connection with wet analysis was, however, exceedingly slow, largely owing to the lack of reagents; but as these were gradually discovered wet analysis rapidly developed, especially in the hands of Tachenius, Scheele, Boyle, Hoffman, Margraf and Bergmann. Boyle (1626–1691) especially had an extensive knowledge of reagents and their application; and, indeed, it was Boyle who first introduced the word 'analysis' for those operations by which substances may be recognized in the presence of one another. Boyle knew how to test for silver with hydrochloric acid, for calcium salts with sulphuric acid, and for copper by the blue solution produced by ammonia.

Margraf (1709–1782) introduced prussiate of potash for the detection of iron, and Bergmann (1735–1784) not only introduced new reagents and new methods for decomposing minerals and refractory substances, such as fusion with potash, digestion with nitric acid or hydrochloric acid, but he also was the first to suggest the application of tests in a systematic way, and, indeed, the method of analysis which he developed is on much the same lines as that in use at the present day. He paid special attention to the qualitative analysis of minerals, and gave careful instructions for the analysis of gold, platinum, silver, lead, copper, zinc and other ores. The work of Scheele (1742–1786) had indirectly a great influence on qualitative analysis, as, although he did not give a general systematic method of procedure in the analysis of substances of unknown composition, yet the methods which he employed in the examination of new substances were so original and exact as to remain models of how qualitative analysis shall be conducted.

Great strides in analytical chemistry in the wet way were made through the work of Berzelius, who, by the discovery of new methods, such as the decomposition of silicates by hydrofluoric acid and the introduction of new tests, greatly advanced the art. He paid special attention to perfecting the methods of analysis of mineral waters, and these researches as well as his work on ores, and particularly his investigation of platinum ores, stamp Berzelius as one of the great pioneers in qualitative and quantitative analytical chemistry.

By the labors of the great experimenters whom I have mentioned qualitative analysis gradually acquired the familiar appearance of to-day, and many books were written with the object of arranging the mass of information which had accumulated, and of thus rendering it available for the student in his efforts to investigate the composition of new minerals and other substances. Among these books may be mentioned the 'Handbuch der analytischen Chemie,' by H. Rose, and especially the well-known analytical text-books of Fresenius, which have had an extraordinarily wide circulation and passed through many editions.

The work of the great pioneers in analytical chemistry was work done often under circumstances of great difficulty, as before the end of the seventeenth century there were no public institutions of any sort in which a practical knowledge of chemistry could be acquired. Lectures were, of course, given from very early times, but it was not until the time of Guillaume François Rouelle (1703–1770), at the beginning of the eighteenth century, that lectures began to be illustrated by experiments. Rouelle, who was very active as a teacher, numbered among his pupils many men of eminence, such as Lavoisier and Proust, and it was largely owing to his influence that France took such a lead in practical teaching. In Germany progress was much slower, and in our country the introduction of lectures illustrated by experiments seems to have been mainly due to Davy.

When it is considered how slowly experimental work came to be recognized as a means of illustration and education, even in connection with lectures, it is not surprising that in early times practical teaching in laboratories should have been thought quite unnecessary.

The few laboratories which existed in the sixteenth century were built mainly for the practice of alchemy by the reigning princes of the time, and, indeed, up to the beginning of the nineteenth century, the private laboratories of the great masters were the only schools in which a favored few might study, but which were not open to the public. Thus we find that Berzelius received in his laboratory a limited number of students who worked mostly at research: these were not usually young men, and his school cannot thus be considered as a teaching institution in the ordinary sense of the word.

The earliest laboratory open for general instruction in Great Britain was that of Thomas Thomson, who after graduating in Edinburgh in 1799, began lecturing in that city in 1800, and opened a laboratory for the practical instruction of his pupils. Thomson was appointed lecturer in Chemistry in Glasgow University in 1807, and Regius Professor in 1818, and in Glasgow he also opened a general laboratory.

The first really great advance in laboratory teaching is due to Liebig, who, after working for some years in Paris under Gay-Lussac, was appointed in 1824 to be Professor of Chemistry in Giessen. Liebig was strongly impressed with the necessity for public institutions where any student could study chemistry, and to him fell the honor of founding the world-famed Giessen Laboratory, the first public institution in Germany which brought practical chemistry within the reach of all students.

Giessen rapidly became the center of chemical interest in Germany, and students flocked to the laboratory in such numbers as to necessitate the development of a systematic course of practical chemistry, and in this way a scheme of teaching was devised which, as we shall see later, has served as the foundation for the system of practical chemistry in use at the present day.

When the success of this laboratory had been clearly established many other towns discovered the necessity for similar institutions, and in a comparatively short time every university in Germany possessed a chemical laboratory. The teaching of practical chemistry in other countries was, however, of very slow growth; in France, for example, Wurtz in 1869 drew attention to the fact that there was at that time only one laboratory which could compare with the German laboratories, namely, that of the École Normale Supérieure.

In this country the provision of suitable laboratories for the study of chemistry seems to date from the year 1845, when the College of Chemistry was founded in London, an institution which under A. W. Hofmann's guidance rapidly rose to such a prominent position.

In 1851 Frankland was appointed to the chair of chemistry in the new college founded in Manchester by the trustees of John Owens, and here he equipped a laboratory for the teaching of practical chemistry. Under Sir Henry Roscoe this laboratory soon became too small for the growing number of chemical students, a defect which was removed when the new buildings of the college were opened in 1873. In 1849 Alexander Williamson was appointed Professor of Practical Chemistry at University College, London, where he introduced the practical methods of Liebig.

Following these examples, the older universities gradually came to see the necessity for providing accommodation for the practical teaching of chemistry, with the result that well-equipped laboratories have been erected in all the centers of learning in this country.

Since Liebig, by the establishment of the Giessen Laboratory, must be looked upon as the pioneer in the development of practical laboratory teaching, it will be interesting to endeavor to obtain some idea of the methods which he used in the training of the students who attended his laboratory in Giessen. From small beginnings he gradually introduced a systematic course of practical chemistry, and a careful comparison shows that this was similar in many ways to that in use at the present day. The student at Giessen, after preparing the more important gases, was carefully trained in qualitative and quantitative analysis; he was then required to make a large number of preparations, after which he engaged in original research.

Although there is, as far as I have been able to ascertain, no printed record of the nature of the quantitative work and the preparations which Liebig required from his students, the course of qualitative analysis is easily followed, owing to the existence of a most interesting book published for the use of the Giessen students.

In 1846, at Liebig's request, Henry Will, Ph.D., Extraordinary Professor of Chemistry in the University of Giessen, wrote a small book, for use at Giessen, called 'Giessen Outlines of Analysis,' which shows clearly the kind of instruction given in that laboratory at the time in so far as qualitative analysis is concerned. This book, which contains a preface by Liebig, is particularly interesting on account of the fact that it is evidently the first Introduction to Analysis intended for the training of elementary students which was ever published. In the preface Liebig writes: "The want of an introduction to chemical analysis adapted for the use of a laboratory has given rise to the present work, which contains an accurate description of the course I have followed in my laboratory with great advantage for twenty-five years. It has been prepared at my request by Professor Will, who has been my assistant during a great part of this period."

This book undoubtedly had a considerable circulation, and was used in most of the laboratories which were in existence at that time, and thus we find, for example, that the English translation which Liebig 'hopes and believes will be acceptable to the English public' was the book used by Hofmann for his students at the College of Chemistry. In this book the metals are first divided into groups much in the same way as is done now; each group is then separately dealt with, the principal characteristics of the metals of the group are noted, and their reactions studied. Those tests which are useful in the detection of each metal are particularly emphasized, and the reasons given for selecting certain of them as of special value for the purposes of separating one metal from another.

Throughout this section of the book there are frequent discussions as to the possible methods of the separation, not only of the metals of one group, but of those belonging to different groups; and the whole subject is treated in a manner which shows clearly that Liebig's great object was to make the student think for himself. After studying in a similar manner the behavior of the principal acids with reagents, the student is introduced to a course of qualitative analysis comprising, 1, preliminary examination of solids; 2, qualitative analysis of the substance in solution.

Both sections are evidently written with the object, not only of constructing a system of qualitative analysis, but more particularly of clearly leading the student to argue out for himself the methods of separation which he will ultimately adopt. The book concludes with a few tables which differ considerably in design from those in use at the present day, and which are so meager that the student could not possibly have used them mechanically.

The system introduced in this book, no doubt owing to the excellent results obtained by its use, was rapidly recognized as the standard method of teaching analysis in most of the institutions existing at that time. Soon the course began to be further developed, book after book was published on the subject, and gradually the teaching of qualitative analysis assumed the shape and form with which we are all so well acquainted. But the present-day book on qualitative analysis differs widely from 'Giessen Outlines' in this respect, that whereas in the latter the tables introduced are mere indications of the methods of separation to be employed, and are of such a nature that the student who did not think for himself must have been constantly in difficulties, in the book of the present day these tables have been worked out to the minutest detail. Every contingency is provided for; nothing is left to the originality of the student; and that which, no doubt, was once an excellent course has now become so hopelessly mechanical as to make it doubtful whether it retains anything of its former educational value.

The question which I now wish to consider more particularly is whether the system of training chemists which is at present adopted, with little variation, in our colleges and universities is a really satisfactory one, and whether it supplies the student with the kind of knowledge which will be of the most value to him in his future career.

Those who study chemistry may be roughly divided as to their future careers into two groups—those who become teachers and those who become technical chemists. Now, whether the student takes up either the one or the other career, I think that it is clear that the objects to be aimed at in training him are to give him a sound knowledge of his subject, and especially to so arrange his studies as to bring out in every possible way his capacity for original thought.

A teacher who has no originality will hardly be successful, even though he may possess a very wide knowledge of what has already been done in the past. He will have little enthusiasm for his subject, and will continue to teach on the lines laid down by the text-books of the day, without himself materially improving the existing methods, and, above all, he will be unable, and will have no desire, to add to our store of knowledge by original investigation.

It is in the power of almost every teacher to do some research work, and it seems probable that the reason why more is not done by teachers is because the importance of research work was not sufficiently insisted on, and their original faculty was not sufficiently trained, at the schools and colleges where they received their education.

And these remarks apply with equal force to the student who subsequently becomes a technical chemist.

In the chemical works of to-day sound knowledge is essential, but originality is an even more important matter. A technical chemist without originality can scarcely rise to a responsible position in a large works, whereas a chemist who is capable of constantly improving the process in operation, and of adding new methods to those in use, becomes so valuable that he can command his own terms.

Now, this being so, I think it is extraordinary that so many of the students who go through the prescribed course of training—say for the Bachelor of Science degree —not only show no originality themselves, but seem also to have no desire at the conclusion of their studies to engage in original investigation under the supervision of the teacher. That this is so is certainly my experience as a teacher examiner, and I feel sure that many other teachers will endorse this view of the case.

If we inquire into the reason for this deficiency in originality we shall, I think, be forced to conclude that it is in a large measure due to the conditions of study and the nature of the courses through which the student is obliged to pass.

A well-devised system of quantitative analysis is undoubtedly valuable in teaching the student accurate manipulation, but it has always seemed to me that the long course of qualitative analysis which is usually considered necessary, and which generally precedes the quantitative work, is not the most satisfactory training for a student.

There can be no doubt that to many students qualitative analysis is little more than a mechanical exercise: the tables of separation are learnt by heart, and every substance is treated in precisely the same manner: such a course is surely not calculated to develop any original faculty which the student may possess. Then, again, when the student passes on to quantitative analysis, he receives elaborate instructions as to the little details he must observe in order to get an accurate result; and even after he has become familiar with the simpler determinations he rarely attempts, and indeed has no time to attempt, anything of the nature of an original investigation in qualitative or quantitative analysis. It indeed sometimes happens that a student at the end of his second year has never prepared a pure substance, and is often utterly ignorant of the methods employed in the separation of substances by crystallization; he has never conducted a distillation, and has no idea how to investigate the nature and amounts of substances formed in chemical reactions; practically all his time has been taken up with analysis. That this is not the way to teach chemistry was certainly the opinion of Liebig, and in support of this I quote a paragraph bearing on the subject which occurs in a very interesting book on 'Justus von Liebig: his Life and Work,' written by W. A. Shenstone (pp. 175, 176).

"In his practical teaching Liebig laid

great stress on the producing of chemical preparations; on the students preparing, that is to say, pure substances in good quantity from crude materials. The importance of this was, even in Liebig's time, often overlooked; and it was, he tells us, more common to find a man who could make a good analysis than to find one who could produce a pure preparation in the most judicious way.

"There is no better way of making one's self acquainted with the properties of a substance than by first producing it from the raw material, then converting it into its compounds, and so becoming acquainted with them. By the study of ordinary analysis one does not learn how to use the important methods of crystallization, fractional distillation, nor acquire any considerable experience in the proper use of solvents. In short, one does not, as Liebig said, become a chemist."

One reason why the present system of training chemists has persisted so long is no doubt because it is a very convenient system: it is easily taught, does not require expensive apparatus, and, above all, it lends itself admirably for the purpose of competitive examination.

The system of examination which has been developed during the last twenty years has done much harm, and is a source of great difficulty to any conscientious teacher who is possessed of originality, and is desirous, particularly in special cases, of leaving the beaten track.

In our colleges and universities most of the students work for some definite examination—frequently for the Bachelor of Science degree—either at their own University or at the University of London.

For such degrees a perfectly definite course is prescribed and must be followed, because the questions which the candidate will have to answer at his examination are based on a syllabus which is either published or is known by precedent to be required. The course which the teacher is obliged to teach is thus placed beyond his individual power of alteration, except in minor details, and originality in the teacher is thereby discouraged: he knows that all students must face the same examination, and he must urge the backward man through exactly the same course as his more talented neighbor.

In almost all examinations salts or mixtures of salts are given for qualitative analysis. 'Determine the constituents of the simple salt A and of the mixture B' is a favorite examination formula; and as some practical work of this sort is sure to be set, the teacher knows that he must contrive to get one and all of his students into a condition to enable them to answer such questions.

If, then, one considers the great amount of work which is required from the present-day student, it is not surprising that every aid to rapid preparation for examination should be accepted with delight by the teacher; and thus it comes about that tables are elaborated in every detail, not only for qualitative analysis in inorganic chemistry, but, what is far worse, for the detection of some arbitrary selection of organic substances which may be set in the syllabus for the examination. I question whether any really competent teacher will be found to recommend this system as one of educational value or calculated to bring out and train the faculty of original thought in students.

If, then, the present system is so unsatisfactory, it will naturally be asked, how are students to be trained, and how are they to be examined so as to find out the extent of the knowledge of their subject which they have acquired?

In dealing with the first part of the question—that is, the training best suited to chemists—I can, of course, only give my own views on the subject—views which, no doubt, may differ much from those of many of the teachers present at this meeting. The objects to be attained are, in my opinion, to give the student a sufficient knowledge of the broad facts of chemistry, and at the same time so to arrange his practical work in particular as to always have in view the training of his faculty of original thought.

I think it will be conceded that any student, if he is to make his mark in chemistry by original work, must ultimately specialize in some branch of the subject. It may be possible for some great minds to do valuable original work in more than one branch of chemistry, but these are the exceptions; and as time goes on, and the mass of facts accumulates, this will become more and more impossible. Now a student at the commencement of his career rarely knows which branch of the subject will fascinate him most, and I think, therefore, that it is necessary, in the first place, to do all that is possible to give him a thorough grounding in all branches of the subject. In my opinion the student is taken over too much ground in the lecture courses of the present day: in inorganic chemistry, for example, the study of the rare metals and their reactions might be dispensed with, as well as many of the more difficult chapters of physical chemistry, and in organic chemistry such complicated problems as the constitutions of uric acid and the members of the camphor and terpene series, etc., might well be left out. As matters stand now, instruction must be given on these subjects simply because questions bearing on them will probably be asked at the examination.

And here perhaps I might make a confession, in which I do not ask my fellow-teachers to join me. My name is often attached to chemistry papers which I should be sorry to have to answer; and it seems to me the standard of examination papers, and especially of Honors examination papers, is far too high. Should we demand a pitch of knowledge which our own experience tells us can not be maintained for long?

In dealing with the question of teaching practical chemistry it may be hoped, in the first place, that in the near future a sound training will be given in elementary science in most schools, very much on the lines which I mentioned in the first part of this address. The student will then be in a fit state to undergo a thoroughly satisfactory course of training in inorganic chemistry during his first two years at college. Without wishing in any way to map out a definite course, I may be allowed to suggest that instead of much of the usual qualitative and quantitative analysis, practical exercises similar to the following will be found to be of much greater educational value.

(1) The careful experimental demonstration of the fundamental laws of chemistry and physical chemistry.

(2) The preparation of a series of compounds of the more important metals, either from their more common ores or from the metals themselves. With the aid of the compounds thus prepared the reactions of the metals might be studied and the similarities and differences between the different metals then carefully noted.

(3) A course in which the student should investigate in certain selected cases: (*a*) the conditions under which action takes place; (*b*) the nature of the products formed; (*c*) the yield obtained. If he were then to proceed to prepare each product in a state of purity, he would be doing a series of exercises of the highest educational value.

(4) The determination of the combining weights of some of the more important metals. This is in most cases comparatively simple, as the determination of the combining weights of selected metals can be very accurately carried out by measuring

the hydrogen evolved when an acid acts upon them.

Many other exercises of a similar nature will readily suggest themselves, and in arranging the course every effort should be made to induce the student to consult original papers and to avoid as far as possible any tendency to mere mechanical work.

The exact nature of such a course must, however, necessarily be left very much in the hands of the teacher, and the details will no doubt require much consideration; but I feel sure that a course of practical inorganic chemistry, could be constructed which, while teaching all the important facts which it is necessary for the student to know, will, at the same time, constantly tend to develop his faculty of original thought.

Supposing such a course were adopted (and the experiment is well worth trying), there still remains the problem of how the student who has had this kind of training is to be examined.

With regard to his theoretical work there would be no difficulty, as the examination could be conducted on much the same lines as at the present time. In the case of the practical examination I have long felt that the only satisfactory method of arriving at the value of a student's practical knowledge is by the inspection of the work which he has done during the whole of his course of study, and not by depending on the results of one or two days' set examination. I think that most examiners will agree with me that the present system of examination in practical chemistry is highly unsatisfactory. This is perhaps not so apparent in the case of the qualitative analysis of the usual simple salt or mixture; but when the student has to do a quantitative exercise, or when a problem is set, the results sent in are frequently no indication of the value of the student's practical work. Leaving out of the question the possibility of the student being in indifferent health during the short period of the practical examination, it not infrequently happens that he, in his excitement, has the misfortune to upset a beaker when his quantitative determination is nearly finished, and as a result he loses far more marks than he should do for so simple an accident.

Again, in attacking a problem he has usually only time to try one method of solution, and if this does not yield satisfactory results he again loses marks; whereas in the ordinary course of his practical work, if he were to find that the first method was faulty he would try other methods until he ultimately arrived at the desired result.

It is difficult to see why such an unsatisfactory system as this might not be replaced by one of inspection, which I think could easily be so arranged as to work well.

A student taking, say, a three years' course for the degree of Bachelor of Science might be required to keep very careful notes of all the practical work which he does during this course, and in order to avoid fraud his notebook could from time to time be initialed by the professor or demonstrator in charge of the laboratory. An inspection of these notebooks could then be made at suitable times by the examiners for the degree, by which means a very good idea would be obtained of the scope of the work which the student had been engaged in, and if thought necessary a few questions could easily be asked in regard to the work so presented. Should the examiners wish to further test the candidate by giving him an examination, I submit that it would be much better to set him some exercise of the nature of a simple original investigation, and to allow him two or three weeks to carry this out, than to depend on the hurried work of two or three days.

The object which I had in view in writing this address was to call attention to the fact that our present system of training in chemistry does not appear to develop in the student the power of conducting original research, and at the same time to endeavor to suggest some means by which a more satisfactory state of things might be brought about. I have not been able, within the limits of this address, to consider the conditions of study during the third year of the student's career at college, or to discuss the increasing necessity for extending that course and insisting on the student carrying out an adequate original investigation before granting him a degree, but I hope on some future occasion to have the opportunity of returning to this very important part of the subject. If any of the suggestions I have made should prove to be of practical value and should lead to the production of more original research by our students, I shall feel that a useful purpose has been served by bringing this matter before this Section. In concluding I wish to thank Professor H. B. Dixon, Professor F. S. Kipping, and others, for many valuable suggestions, and my thanks are especially due to Dr. Bevan Lean for much information which he gave me in connection with that part of this address which deals with the teaching of chemistry in schools.

W. H. PERKIN.

SCIENTIFIC BOOKS.

La face de la terre. By EDOUARD SUESS. Translated from the German *Das Antlitz der Erde*, by EMMANUEL DE MARGERIE and others. Vol. II. Paris, Armand Colin & Cie., 1900. Pp. 878.

The first volume of this important translation has already been noticed in the pages of SCIENCE (Vol. VII., p. 803). The second volume contains the third part of the work dealing with 'The Seas.' After a brief review of the opinion of geographers concerning the question of changes of level of the sea in relation to the land, Suess adopts a terminology intended to avoid any implication of the movement of the land in relation to the sea in observed displacement of shore-lines. These 'shifts of relative level,' as Robert Chambers termed them, are then qualified as *negative* when the sea-level appears to fall and positive when it appears to rise, in accordance with the terminology employed in reading tide-gauges. For the expression 'elevation of the continent,' we may substitute then 'negative displacement of the shore-line,' and for 'submergence of the continent,' positive displacement.

The geological structure of the lands about the Atlantic is treated with much care in order to bring out the history of displacements of shore-line in this part of the world. A similar discussion is devoted to the contours of the Pacific Ocean. In summarizing the characters of these two great ocean basins, Suess finds that "with the exception of the Cordillera of the Antilles and of the mountainous trunk of Gibraltar which circumscribes the two Mediterraneans, no part of the contours of the Atlantic Ocean is determined by a folded chain. The internal border with groups of folds, the coasts cut by rias indicating a sinking of chains, the inclined fractures of horsts and the step-faults—such are the varied elements which determine the plan of the shores of the Atlantic Ocean."

As for the Pacific Ocean, "with the exception of a segment of the coast of Central America in Guatemala where the Cordillera making the turn of the Antilles is depressed, all parts of the border of the Pacific Ocean, of which the geology is known, are formed by chains of mountains folded towards the ocean in such a way that their external plications serve to outline the continent itself or constitute a belt of peninsulas and aligned islands." He then considers the ancient Paleozoic seas with the view of sifting the evidence which their sediments and faunas present in relation to the question of 'submergence and emergence of lands' and 'movements of the hydrosphere.' Our author finds insuperable difficulties in the commonly accepted explanation, and in this and following sections of the work develops the idea of swayings of the ocean waters alternately towards the equator and the poles to account for the numerous instances of advance and retreat of the sea afforded by the Paleozoic and Mesozoic formations of the existing continents. Mesozoic and Tertiary geology are treated in the same comprehensive way, in the endeavor to show the former relations of sea-level to the lands.

In the last chapter of this volume, Suess gives the principal points in his theory. "Once," he states, "that the marine depressions are regarded as sunken tracts, the continents acquire the character of horsts, and the pointed form directed towards the south, in the case of Africa, India and Greenland, is explained by the intersection of fields of sinking of which the principal domain is found in the south.

"The crust of the earth sinks; the sea follows it. But inasmuch as the sinkings of the lithosphere are limited in extent, the lowering of the surface of the sea affects the entire perimeter of the oceanic areas; it produces a general negative movement.

"The formation of sediments causes a positive uninterrupted eustatic displacement of the shore-lines." Other causes, such as variation in the quantity of water in the seas dependent upon the rate of formation of silicates and upon the variable action of volcanoes, give rise also to eustatic movements of the ocean. These changes with the movements of the ocean above noted form the outlines of his theory.

Suess appears to be placed in the necessity of minimizing the changes of level which many geologists have postulated in recent geologic time, for these supposed changes exceed the effects attributable to the operations which he invokes. Thus, to take but one example of evidence adduced in favor of profound alteration of level—that of the so-called submarine gorges of the Hudson, the Congo, and other rivers, Suess contends with Forel and others that these channels are the result of excavation and deposition now going on as in Lake Geneva. In this view such cañons are not criteria of change of level. To this criticism of the doctrine of extreme changes of recent level may be added that made by Davis upon the interpretation of fjords in high glaciated latitudes, that the ice has excavated the deep fjords and that their depth below sea level is not necessarily a measure of depression of the land (Proc. Boston Soc. Nat. His., Vol. XXIX. 227–322. 1900). So also the high terraces reported in the far north are not without close scrutiny to be taken as evidence of elevation since there are diverse kinds of terraces, some of them built in ice-confined waters far above sea-level.

It is understood that the venerable author of *Das Antlitz der Erde* has in preparation a concluding section of his great work. In that we may expect to find the discussion of many questions, which his singularly attractive hypothesis of a swinging, rising and falling ocean raises, in the light of the work of Lord Kelvin and other physico-geologists upon the rate of contraction of the earth and upon the apparent tilting of a continent with its Great Lakes, as in the case of North America.

The two volumes of the new French edition form perhaps the best summary extaut of the geology of the globe and should find an English translator.

J. B. Woodworth.

Mesures électrique; essais laboratoire. By E. Vigneron and P. Letheule. Paris, Gauthier Villars. (No date.)

Resistance électrique et fluidité. By Gouré de Villemonteé, Paris. Gauthier-Villars. (No date.)

These two small octavo volumes, of one hundred aud eighty and one hundred and eighty-seven pages respectively, are installments of the *Encyclopédie scientifique des aide-mémoire.* The first contains a good discussion of the methods for measuring electric current, electromotive force, resistance, electrostatic capacity and self-induction.

The second is a very complete résumé of the experimental work that has been done in the attempt to discover the relationship between the electrical resistance of electrolytes and their viscosity.

Vigneron and Letheule devote eight introductory pages to *généralités sur les grandeurs.* They say that "une grandeur est dite mesurable quand on peut la comparer à une grandeur de même espèce et que le résultat de la comparaison donne à notre esprit une satisfaction complète." This statement is, indeed, somewhat cleared up by subsequent statements given by the authors, but on the whole the introduction seems very unsatisfactory.

Length, angle, mass and time are called measurable quantities because these attributes (to speak of them briefly) may be divided into parts, which by means of one or another kind of congruence, are judged to be equal or like parts, and these parts may then be counted. This fundamental notion which is due, we believe, to Helmholtz, is no doubt the real basis of quantitative relations in physics; and it should be remembered that, although we frequently speak of the measurement of an electric current, of a magnetic field and what not, we never do actually measure anything but lengths, angles, masses and time intervals.

In the first chapter, on electrical units and quantities, Vigneron and Letheule make a distinction between *electromotive force* and *potential difference*, which distinction, being largely in vogue among electricians and not being based upon the fundamental conception of potential, it is a disservice to perpetuate. A distinction, however, there certainly is between the two, and it is, according to Maxwell, as follows:

When electric charge is transferred from one point to another work is usually done. The amount of work done depends in general upon the path along which the charge is carried. The work done in carrying unit charge along a given path is called the *electromotive force* along that path.

In special cases the electromotive force is the same along any two coterminus paths. In such a case the common value of the electromotive force is called the *potential difference* between the terminal points.

Now it seems to us that no author should attempt to make any other distinction between electromotive force and potential difference than the above. In particular the distinction between the *total electromotive* force of an electric generator and the *electromotive force between the terminals of the generator* should not be confused with the distinction between electromotive force and potential difference. One may answer, indeed, that the practical electrician is concerned with the distinction between *total* and *external* electromotive forces of electric generators, and not at all concerned with the fine distinction, according to Maxwell, between electromotive force and potential difference. This is too true, but this is no reason why electricians should be permitted to misuse these terms without protest, for very certainly the distinction between total and external electromotive force of a generator has nothing essentially in common with the distinction between electromotive force and potential difference in the sense in which Maxwell uses these terms.

There is one thing in which we know of only one person (Heaviside) who agrees with us, namely, that the notion of electric potential might best be dropped in the subject of electrodynamics, and we are convinced that the preference of most electricians for the term *potential* to the term *electromotive force* is in their tongues, not in their heads.

W. S. FRANKLIN.

BOOKS RECEIVED.

Text-book of Physiology. Edited by E. A. SCHÄFER. Edinburgh and London, Young J. Pentland. New York, The Macmillan Company. 1900. Vol. II., pp. xxiv + 1365. $10.00.

The Theory and Practice of Hygiene. J. LANE NOTTER and W. H. HORROCKS. Philadelphia, P. Blakiston's Sons & Co. 1900. Second Edition. Pp. xvii + 1085. $7.00.

A Treatise on Zoology. Edited by E. RAY LANKESTER. Part II., *The Porifera and Cœlentera.* E. A. MINCHIN, G. HERBERT FOWLER and GILBERT C. BOURNE. London, Adam and Charles Black. New York, The Macmillan Company. 1900. $5.50.

Free-hand Perspective. VICTOR T. WILSON. New York, John Wiley & Sons. London, Chapman & Hall, Limited. 1900. Pp. xii + 268. $2.50.

Dynamo Electric Machinery. SAMUEL SHELDON. New York, D. Van Nostrand Company. 1900. Pp. 281. $2.50.

Die Lehre von Skelet des Menschen. F. FRENKEL Jena, Gustav Fischer. 1900. Pp. vi + 176. M. 4.50.

Among the Mushrooms. ELLEN M. DALLAS and CAROLINE A. BURGEN. New York, Drexel Biddle. 1900. Pp. xi + 175.

The Principles of Mechanics. FREDERICK SLATE. New York and London, The Macmillan Company. 1900. Pp. x + 299.

Die Ursprüngliche Verbreitung der angebauten Nutzpflanzen. F. Höck. Leipzig, Teubner. 1900. Pp. 78. M. 1.60.

Lehrbuch der vergleichenden mikroskopischen Anatomie der Wirbeltiere. Albert Oppel. Jena, Gustav Fischer. 1900. Part III. Pp. x + 1180 and 10 plates.

A School Chemistry. John Waddell. New York and London, The Macmillan Company. 1900. Pp. xiii + 278.

SCIENTIFIC JOURNALS AND ARTICLES.

Popular Astronomy for October contains an excellent sketch by Professor C. D. Perrine of the late James Edward Keeler, of Lick Observatory, accompanied by his photograph. The opening address by Dr. A. A. Common, F.R.S., F.R.A.S., at the Bradford meeting of the British Astronomical Association for the Advancement of Science is begun in this number and will be concluded in the November number. Also the first part of Kurt Laves' paper on 'The Adjustment of the Equatorial Telescope' is given. Tables for the observation of the planet Eros and an illustrated article upon that planet by the editor, W. W. Payne, together with a résumé of recent work at the Lowell Observatory are important features of this issue, as well as the usual spectroscopic, planet, comet and general notes.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

At the meeting of the Society on October 13th, Mr. O. H. Tittmann told in an informal way of some of the incidents of the marking of the provisional boundary between Alaska and the British possessions, at the head of the Lynn Canal, during the past summer.

Dr. Artemus Martin read a paper on 'A Method of Computing the Logarithm of a Number without making use of any Logarithm but that of 10 or some power of 10.' The method in this paper consists in modifying some of the ordinary forms of logarithmic series so that the logarithm used in the computation is the logarithm of 10 or some power of 10.

Dr. T. J. J. See read a paper on the 'System of Uranus.' It combines a statement of some of the recent results of observations, a comparison of these with former results and a critical statement of the uncertainties involved in the present knowledge of the system.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the first meeting of the autumn, held on the evening of October 15th, there were sixteen persons present. Mr. William H. Roever, of Washington University, presented an elaborate paper, discussing in detail the subject of the establishment of the method of least squares. Professor F. E. Nipher presented two papers, entitled respectively 'Positive Photography,' with special reference to eclipse work and the frictional effects of railway trains upon the air ; and Mr. C. F. Baker exhibited an interesting collection representing nearly all of the species of fleas thus far known, which he had prepared for the United States National Museum.

Four persons were elected to active membership.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

ARITHMETICAL NOTE.

In the second edition of the *Exercices d'arithmétique* of MM. Fitzpatrick and Chevrel (Paris, Hermann, 1900), there is given the following interesting application of the binary system of notation (p. 490). Russian peasants, when they have to perform a multiplication, in general proceed thus: They divide the multiplicand by 2, and at the same time double the multiplier ; if the multiplicand is odd, they discard the unit remainder and mark the multiplier with a sign. This being done as often as possible, the multipliers affected with the sign are added together to obtain the result. Thus, for example, the multiplication of 35 by 42 proceeds as follows :

35........................	42 +
17........................	84 +
8........................	168
4........................	336
2........................	672
1........................	1344 +

$42 + 84 + 1344 = 1470.$

It is easy enough to construct a similar process, *e. g.*, for the ternary system of notation; the example might then be worked out in this manner:

35........................ 42 —
12........................ 126
4........................ 378 +
1........................1134 +
378 + 1134 — 42 = 1470;

but the possibility of constructing similar processes throws no light on the origin of such a method among the Russian peasants.

C. A. SCOTT.

CAMPHOR SECRETED BY AN ANIMAL.

TO THE EDITOR OF SCIENCE: Mr. O. F. Cook's article in a recent number of SCIENCE recalls some observations by the late E. D. Cope. Cope wrote (*Trans. Amer. Entom. Soc.*, Vol. 3, May, 1870, pp. 66–67), as follows: "The species of *Spirobolus* and *Julus* discharge a yellowish juice having much the smell of aqua regia and a very acrid taste. The *Spirostrephon lactarius* exudes from a series of lateral pores a fluid which has in its odor a close resemblance to creasote. The *Polydesmus virginiensis* is defended by a fluid which has almost exactly the smell of hydrocyanic acid and is fatal to small animals. *Petaserpes rosalbus* secretes a considerable quantity of a milky substance, which has the perfume of gum camphor."

Quite possibly there are other references to the subject, but I have not examined the literature of the Myriapoda very carefully.

NATHAN BANKS.

EAST END, VA.

A CORRECTION.

TO THE EDITOR OF SCIENCE: In the issue of SCIENCE for October 19th I notice your statement under 'University and Educational News' of my appointment as acting president of Wells College. Permit me to say that a misspelling of my name completely changes it into that of another person. Instead of *Feeley*, it should be *Freley*.

J. W. FRELEY.

BOTANICAL NOTES.

PROLIXITY IN BOTANICAL PAPERS.

WHAT botanist has not groaned in spirit in these recent years over the increasing prolixity of American botanical writers? There was a time when it was the exception for a botanist to write a paper of great length, and some of us were a little ashamed of what appeared to be the inability of botanical writers to prepare papers whose length, at least, would suggest profundity. Doubtless at that time there were fewer men who could write anything better than short notes, and perhaps there was some need of a change. But now, alas, we have learned the lesson only too well. One takes up journal after journal and finds that many of the papers are drawn out through pages and pages until in very weariness he turns to the 'conclusions,' hoping to obtain a summary of the author's results, often to find that here, too, there is such prolixity as to suggest the need of a 'summary' of the 'conclusions.'

Is it not time that botanical teachers gave some instruction in conciseness of statement, while they are making investigators out of the raw material which they find in their classes? Paper and ink do not cost much, and the long-suffering editors of botanical journals have not made, as yet, any audible protest, but we speak for the readers of these long-drawn out papers whose time is too valuable to be given to the absorption and assimilation of the vast mass of excellent but uncondensed matter which now-a-days finds publication. Many a good paper would be much more readable if condensed to half its length, while at the same time it would lose nothing in clearness of statement of all essential facts.

THE STUDY OF PLANT DISEASES.

AN instructive paper by Mr. Galloway, in the 'Yearbook of the Department of Agriculture' for 1899, gives a brief history of the development of the study of plant pathology in the United States. Little has been done by American botanists previous to 1875, and practically nothing at all by the Government. With the establishment of the agricultural experiment stations, an impetus was given to the beginnings made by Professors Farlow, Burrill and Arthur, and about the same time in the Department of Agriculture a beginning was made of what eventually developed into the Division of Vegetable Physiology and Pathology. This was done by the appointment of Professor

Lamson Scribner to be assistant botanist, with instructions to devote himself to the study of plant diseases. For a minor and secondary place in the Division of Botany, this work, thus begun, has grown into a separate division with a large force of trained physiologists and pathologists. With this development in Washington, there has been a corresponding growth in the work in the experiment stations, while in many of the agricultural colleges and larger universities courses of study in plant physiology and pathology have been introduced into the botanical departments. Where but a few years ago so little was done in the study of plant diseases that the term 'plant pathology' was almost unknown, good introductory courses in physiology and pathology are now offered, and increasing numbers of young men are familiarizing themselves with the scientific and practical aspects of the problems involved.

THE ANNUAL SHEDDING OF COTTONWOOD TWIGS.

Just now (the middle of October) the Cottonwood trees (*Populus deltoides* Marsh.) are shedding their twigs, the ground beneath the large trees being well littered over with fallen twigs of all sizes. This curious phenomenon has been noticed repeatedly, but still it appears not to be generally known, even by botanists. As the autumn advances the cortical tissues of the bases of many of the twigs become so much swollen as to produce bulbous enlargements. At the same time there is a loosening of the woody tissues in the same region, the result being that the woody cylinder is larger in diameter at the base of each affected twig, and the wood-wedges are separated from one another by thicker medullary rays. There appears to be a good deal of longitudinal tension exerted by the swollen cortical tissues, the result being that the woody tissues are pulled asunder, showing a complete transverse fracture of the whole of the woody cylinder. A breeze now easily fractures the cortical tissues and the twig drops to the ground.

There is much apparent waste in this shedding of these twigs, since they invariably have large, well-formed terminal buds and generally a good many lateral buds also. Among the latter one often finds well-grown flower buds. These facts show that the twigs which are shed are not the feeble and dying ones, but are among the most vigorous and active on the trees. It is an interesting fact that the Tamarisks (*Tamarix* sp.), which are held by some botanists to be closely related to the Poplars, shed their twigs by exactly the same device as that described above. In the Tamarisks the shedding of the twigs is a part of the annual process of defoliation, their leaves being so small that it appears to be less trouble and expense to drop twig and all than to separate every individual leaf. Possibly in the Cottonwoods, with their large leaves, we have a survival of the Tamarisk twig-shedding habit long after its original significance has disappeared.

THE IMMEDIATE EFFECT OF POLLEN.

For a long time it has been known that in the crossing of some plants the pollen seems to produce an effect upon more than the embryo, in other words, that not only the embryo but other structures, also, show evidences of hybridity. Focke named this phenomenon *xenia* in a paper published nearly twenty years ago, and this is the term now used by writers of papers on this subject. The latest paper is an exceedingly interesting one by H. J. Webber: 'Xenia, or the Immediate Effect of Pollen, in Maize,' published as a bulletin (No. 22) of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture. In it an attempt is made to throw light upon the real nature and meaning of the phenomenon. Many experiments were made by him to determine whether xenia actually takes place in maize, with the result that its occurrence is no longer to be doubted. It is shown, moreover, that this immediate effect of the pollen is limited to the endosperm of the maize kernel. Thus where a change of color occurs in the hybrid, this color is in the endosperm cells, and furthermore, where the color is in the pericarp (as in the variety known as Red Dent) no change in color takes place.

The explanation suggested by DeVries and Correns in papers published almost simultaneously in December, 1899, that xenia is the result of double fecundation is adopted by Mr. Webber without modification. In fact the same explanation had suggested itself to him early enough in 1899 to enable him to make a number of experiments that year, with a view to obtaining evidence in regard to it. This theoretical explanation, in short, is as follows: As is now admitted, in the process of fecundation (in some plants, at least) not only is there a union of one of the generative nuclei of the pollen tube with the egg nucleus, but also, there is a union of the second generative nucleus with the embryo-sac nucleus. As the endosperm develops from this nucleus thus fecundated, it is clearly a hybrid organism also. In other words, in the fecundation of the egg a hybrid sporophyte is produced, but at the same time the supporting gametophyte (the endosperm) is itself developed as a hybrid. This is possible because of the tardy development of the gametophyte tissue, which is so delayed that actually it is formed simultaneously with that of the sporophyte which it bears, and which it should precede.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

NEW YORK BOTANICAL GARDEN.

IMPROVEMENTS in the New York Botanical Garden are going steadily forward. A contract amounting to $22,000 for grading and roadways near the Museum is approaching completion, and a series of working greenhouses is now under construction in the eastern part of the Garden in a locality little frequented by visitors. These houses comprise two main ranges 20 by 60 feet, storage rooms, potting sheds and an independent heating plant, in which the open hot water system will be used.

The New York Central and Hudson River Railroad is building a new passenger station at the Bedford Park entrance to the Garden. The new station will be of stone and brick costing about $40,000. The offices will be located on the western side of the tracks, connected by a tunnel with the extensive passenger shelters and waiting rooms on the eastern side which open directly into the plaza. The name of the station will be changed to Bronx Park (Botanical Garden) upon completion of the new building which will save much confusion to visitors.

Professor L. M. Underwood spent the summer in investigations upon American ferns in the British Museum, Kew Gardens and the Cosson Herbarium in Paris. The Cosson Herbarium contains the Feé collection, formerly owned by Emperor Dom Pedro of Brazil. The Feé collection has the largest and best set of West Indian ferns in existence.

Other exploration work was carried out in connection with the Garden is as follows: Dr. Rydberg accompanied by Mr. F. K. Vreeland made extensive collections in the Sierra Blanca in southeastern Colorado; Dr. D. T. MacDougal explored the Priest River Forest Reserve, also carrying out investigations under a grant from the American Association; Dr. C. C. Curtis made a series of collections in western Wyoming, Professor F. E. Lloyd in cooperation with Professor Tracy visited the islands in the Mississippi delta; Messrs R. M. Harper and Percy Wilson made collections in Georgia, and Dr. M. A. Howe investigated the marine and land flora of Bermuda and the coast of Maine, also carrying out the terms of a grant from the Peabody fund; Dr. and Mrs. N. L. Britton made a brief tour in the Adirondacks, securing many living specimens of alpine plants for the grounds.

Dr. N. L. Britton is now in Europe for the purpose of securing exhibits from the Paris Exposition and negotiating for the purchase of several herbaria.

Contributions for the conservatories have been received from many sources, the most valuable of which are those given by Miss Helen Gould, Mrs. F. L. Ames and Siebrecht and Son.

The fall lecture course now in progress has been announced as follows:

October 13th. 'Autumn Flowers,' by Mr. Cornelius VanBrunt.

October 20th. 'Evergreen Trees,' by Professor F. E. Lloyd.

October 37th. 'Freezing of Plants,' by Dr. D. T. MacDougal.

November 3d. 'Evolution of Sex in Plants,' by Professor L. M. Underwood.

November 10th. 'Poisonous Plants which Live in our Bodies, and how we contend against them,' by Professor H. H. Rusby.

November 17th. 'The Sedges,' by Professor N. L. Britton.

SCIENTIFIC NOTES AND NEWS.

An oil portrait of Professor Henry A. Rowland, of Johns Hopkins University, painted by Mr. Harper Pennington, has been presented to the University and hung in the large lecture room in the physical laboratory.

Dr. Oscar Loew, for some time expert physiologist in the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, has resigned in order to accept a position in the Agricultural College of the Imperial University of Tokyo, Japan, as lecturer on physiological chemistry. By his resignation the Department loses one of its best investigators in the special field which he occupied. He sailed from Vancouver on October 8th.

Dr. Oustalet has been appointed professor of zoology in the Natural History Museum at Paris, as successor to the late Professor Milne-Edwards.

Professor Bashford Dean, of Columbia University, is spending his Sabbatical year in zoological work in Japan. He has begun his work at the Marine Biological Station of the Government on the east coast.

The expedition to Labrador under Professor Delabarre of Brown University and Dr. Daly of Harvard University has returned, having made numerous observations and collections in Labrador.

The Gold Medal of the Paris Exposition was awarded to Professor A. S. Bickmore, of the American Musem of Natural History, and his assistants especially for the photographic slides illustrating the lectures: 'Across the American Continent' and 'The Hawaiian Islands.' The 'wide system of free education' carried on by this department in cooperation with the State Board of Education was especially mentioned in the award. Professor Bickmore was moreover invited to give two public lectures in the Trocadero illustrating his method of visual instruction.

Dr. B. M. Duggar, of Cornell University, has been elected a member of the German Botanical Society.

Professor H. V. Hilprecht, who has been carrying on explorations in Babylonia, is expected to return to the University of Pennsylvania at the end of the present month.

Mr. Frank M. Chapman, assistant curator of the Department of Vertebrate Zoology, of the American Museum of Natural History, will give a special course of six lectures on birds, at the Museum on Saturday afternoons at three o'clock, beginning November 10th.

Dr. Robert Koch, who is employed by the German Government to investigate tropical diseases, arrived at Marseilles on October 19th from German New Guinea by way of Hong-Kong. He is on his way to Berlin, where he will present to the Academy of Medicine the result of fifteen months' study of malaria in New Guinea, Java and adjacent German territories.

It appears that Elias Howe, the inventor of the sewing machine, is not to be included among the 30 eminent Americans of the Hall of Fame of New York University. A mistake was made in counting up the votes, Howe receiving 47 instead of 53 as originally announced. This leaves 21 panels to be filled two years hence.

The house in which Samuel F. B. Morse lived from 1864 until 1872, at No. 5 West 22d street, New York City, has been torn down and an office building erected in its place. The original house contained a bronze commemorative tablet which was last week moved to the new building. The tablet bears the inscription: "In this house S. F. B. Morse lived for many years and died." Under it has been added: "This tablet was removed from building formerly on this site and replaced A. D. 1900."

Sir Henry Wentworth Dyke Ackland, for many years regius professor of medicine at Oxford, and Radcliffe Librarian, died on October 16th at the age of 85 years. Sir Henry was appointed reader in anatomy at Oxford in 1845 and regius professor of medicine in 1858, resigning the chair in 1894.

A dispatch from Daker, Senegal, states that M. Paul Blanchet, the well-known French explorer, has died of yellow fever. He was about to embark on his return to France.

The positions of assistant in zoology and in mineralogy in the State Museum at Albany will be filled by civil service examination on or about November 10th. The salaries of these positions are $1,200 and $900, respectively. In the examinations, experience and education count three, and the answers to questions on the science seven points. In zoology the examination will have special reference to vertebrate and systematic zoology. The positions are open only to men over twenty-one years of age who must be citizens of New York State.

The government of the Canton of Zurich has voted to increase its annual subsidy to the Concilium Bibliographicum. In the preamble it is stated that this is done in recognition of the high value of the work of the Concilium Bibliographicum, in the hope that others may aid in securing for the undertaking a firm financial basis, with the purpose of offering the full support permitted by the funds at our disposal, be it enacted, etc. This vote which was taken August 15th has led to a similar decision on the part of the town of Zurich, and now a bill has been introduced by the Department of Interior providing for quintupling the federal subsidy and for placing the Concilium under the more immediate control of the Swiss Government. The ultimate result of these votes will doubtless be the expansion of the field of activity of the Concilium, so as to include botany, anthropology, etc., but for the time being all will be done to render the bibliographies now in existence more complete and to issue them more promptly.

The Duke of Abruzzi has given the *Stellar Polare*, the vessel in which he made his recent exploring trip to the North, to the Italian Navy. She is to be kept in the naval arsenal at Spezia as a souvenir.

Mr. Andrew Carnegie has presented £10,000 to the town of Hawick, Roxburgh County, Scotland, for a public library.

The late Edwin H. Bugbee of Danielson, Connecticut, bequeathed $15,000 and his private library to the public library of that town.

The fine new lecture hall of the American Museum of Natural History will be opened with appropriate exercises on Tuesday, October 30th. The president of the institution, Mr. Morris K. Jesup, will receive invited guests from 3 until 6 o'clock. At 4 o'clock some views of the Paris Exposition will be exhibited in the lecture hall by Professor Bickmore. Admission to the new halls in the west wing and an inspection of their archeological and ethnological collections will also be permitted.

The Library Building of the Historical Society of the State of Wisconsin was dedicated on October 19th. The building, which is practically part of the University of Wisconsin, has been erected at a cost of $575,000.

We learn from the *Botanical Gazette* that the Division of Vegetable Physiology and Pathology of the Department of Agriculture has secured a table at the Marine Biological Laboratory at Woods Holl for the use of its staff during the summer months.

The British Museum (Natural History) has started a collection of 'sports' and 'monstrosities' among insects and will be glad to receive contributions from entomologists.

The new dynamometer car which the Illinois Central Railroad has been building for the Mechanical Department of the University of Illinois, is now ready for use. It is fully equipped and is fitted up with every convenience. The car will be put into active service immediately on a series of tests begun some time ago by the Illinois Central.

The collection of rare African antelope skins received in exchange from the Field Columbian Museum are now all mounted and placed on exhibition in the American Museum of Natural History.

As the daily papers have very fully reported, Count von Zeppelin's air-ship made two ascents. On October 17th it stayed in the air about an hour and was apparently able to make some headway against a light breeze. It could not, however, return to its starting point.

The German Anthropological Society held its thirty-first annual meeting at Halle from September 23d to 27th.

The new laboratories at King's College, which have been in course of construction during the past year, are finished and ready for occupation, and the opening ceremony has been fixed for Tuesday, October 30th. Lord

Lister, P.R.S., will deliver an address after which the laboratories will be open for inspection. We learn from the *British Medical Journal* that although a considerable sum has already been subscribed toward defraying the cost of the building, much has still to be raised, and it is hoped that those interested in higher education may see their way to assist the Council to defray the debt. It is also hoped that funds may be available from the reconstituted University of London for the same purpose. The movement for the extension of the College primarily arose from the difficulties experienced by the professors of bacteriology and physiology in dealing with the great increase in their classes which has occurred during recent years, and at the same time to afford space to those who wish to prosecute original research. The already spacious bacteriological laboratory has been nearly doubled in size and a complete bacteriological library added to it. The physiological laboratory is entirely new, the rooms are handsome, well lighted and fitted in a most complete way. The old physiological laboratory has been absorbed by the extension into it of the anatomical department which was previously much cramped for room. The museum has been completely rearranged; the old museum now becomes the architectural department. Geology and botany are provided with new laboratories and other departments which have benefited by the change are physics, materia medica and State medicine.

The *London Standard* states that Dr. Sven Hedin, according to the latest reports, reached Abdal, on the Tarim River, in eastern Turkestan, on June 27th. He states that the Tarim is the largest river in the interior of Asia. He surveyed the river from Arghan to Abdal in a ferryboat. From Jeggeli-ku, where the river becomes a multitude of small lakes, he continued his journey in a craft made up of three canoes lashed together, with a deck surmounted by a felt tent. In the beginning of March he made an excursion from the Yangi-kol, where he had his winter camp, to the southern slope of the Karruk-tagh Mountains, where he surveyed the Kumdarya bed of the Tarim which is now dry. In the neighborhood he found the marks of a large dried-up lake, probably the old Lob-Nor, which lies east of the present Lob-Nor, or rather the four lakes discovered by him in 1896. The dry soil was covered with a thick layer of salt and millions of mussel shells, while the banks held many withered reeds, dead trees, consisting exclusively of poplars and ruins of houses, fortifications, temples, etc., which were often adorned with artistic wood carvings. Dr. Hedin intended to return to this region in the autumn. In the middle of the desert he found and investigated a larger lake of salt water and then returned to his winter camp. During his stay at Abdal he wrote down several songs sung for many generations by the Lob-Nor men when fishing. When he left this district the thermometer registered forty-two degrees above zero, Celsius; whereas it falls to thirty-two degrees below zero during the winter.

We learn from the *American Museum Journal* that the photographs collected by members of the Jesup North Pacific Expedition will be reproduced by the heliotype process in large quarto form, and published under the title 'Ethnographical Album of the North Pacific Coasts of America and Asia.' It is intended to issue the album to subscribers only, in parts of at least 24 plates annually, the whole series to embrace 120 plates. Part I., consisting of 28 plates, illustrating Indian types from the interior of British Columbia, has already appeared.

The British Office of Woods and Forests has purchased from the Duke of Beaufort the Tintern Abbey estate which comprises the famous abbey and 5,334 acres of land. This area includes nearly 3,000 acres of woodland, the most picturesque portions of which are the wooded hills and slopes with a frontage of eight miles on the River Wye. The estate is near the extensive woods of the Crown in the Forest of Dean. At the same time the Crown has also purchased the whole of the Duke's farms surrounding Raglan Castle, 3,169 acres in extent.

During the past summer the division of soils of the department of agronomy at the University of Illinois has undertaken a study of the soils of Illinois. With this end in view, over five hundred samples have been collected from various parts of the State. These samples, which are being prepared for permanent specimens and for purposes of study, represent a large proportion of the many different types of soil which are to be found within the State. It is proposed to study these soils mechanically, chemically and biologically, to determine the individual properties peculiar to each different type, and the proper methods of handling and cropping best adapted to each. The work which has been done indicates that there are numerous problems of a fundamental character and of vital importance which are demanding the attention of the farmers of the State. Not the least among these is the question of soil exhaustion which is beginning to force itself upon the attention of the people of some parts of the State in such a way that its importance and influence are being seriously felt.

DURING the last few years, several thousand samples of drinking water from various ordinary house wells throughout the State have been sent to the State University of Illinois, for analysis and report as to quality. By far the greater proportion of these water samples have proved, upon analysis, to be contaminated with drainage from refuse animal matters and consequently have been regarded with grave suspicion, or have been pronounced unwholesome for use as drink. The present prevalence of typhoid fever in a number of places in the State makes it desirable that the public should remember that the State has made provision for the examination of all suspected waters. It is not practicable to isolate actually the typhoid fever germs or to prove directly their absence from waters submitted for analysis; this for the reason that the work entails more labor and time than is made available by the means which the State provides. However, the chemical examination is sufficient ordinarily to show whether the water is contaminated with house drainage or drainage from refuse animal matters or whether it is free from such contamination. Any citizen of the State may have examinations made of the drinking water in which he is interested, free of charge, by applying to the Department of Chemistry of the State University.

The *Journal* of the Board of Trade, as quoted by the London *Times*, states that deposits of sulphur have been discovered in Russia only in recent years, and that small works for treating the ore have been established at various times, the largest being in Daghestan, in the northern Caucasus. The chief output of these was in 1888, when it reached 1,500 tons, but since then the works have been closed. The deposits in Daghestan are known to be extensive, while the ore contains 20 per cent. of sulphur, and the geological formation is very similar to that in which the Sicilian deposits occur. But the situation is unfavorable, being a mountainous district 4,500 feet above the level of the Caspian, from which it is separated by numerous steep ridges which are difficult to traverse, even for mules. In Russia now only two sulphur works are in operation, and they produce only 1,000 tons a year, while the consumption of sulphur in the country, owing to the growth of the petroleum industry, is about 20,000 tons. The vast bed lately discovered in Trans-Caspia is one of the richest in the world, and will undoubtedly prove of great importance. It comprises several distinct mounds in an area of 23 square miles, and is situated 100 miles from Khiva, near the Amu Daria river and about 170 miles from Askabad on the Trans-Caspian railway. None of the minerals discovered in the province are being worked, and sulphur is doubtless the most important of these. The mounds above mentioned are dome shaped, about 300 feet high, the sulphur being practically exposed, while the ore is generally sandstone and contains on an average 60 per cent. of sulphur. It is estimated that the mounds contain over 9,000,000 tons of sulphur, and the local circumstances are said to be favorable to work on a large scale. Labor is plentiful and cheap, and transportation could be effected by means of a narrow-gauge line to Askabad, and this could be extended beyond the deposits to Khiva, where wool and other commodities may be had in quantities sufficient to make the line profitable. Nor, it is said, are there any engineering difficulties in the construction of such a line.

WE have already called attention to the comparatively few awards made at Paris for American machiuery. The *Electrical World* holds that the country has been unfairly treated. It says : "In electricity, Austria, with 25 entries, had 5 grand prizes and 17 gold medals. The United States, with 283 eutries, had 6 grand prizes and 23 gold medals. In machinery, Switzerland, with 14 entries, got 9 grand prizes and 15 gold medals. The United States, with 282 entries, got a paltry 10 grand prizes and 26 gold medals. The relative proportions are preposterous. We refuse to believe that American machinery, now sweeping Europe, is inferior to the Swiss or Austrian in any such degree as this implies."

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Jane K. Sather, of San Francisco, has given $1000,000 to the University of California.

It is reported that three alumni of Yale University have offered to subscribe each $100,000 for the memorial building in case the further sum of $300,000 is secured.

The United States Supreme Court has finally rendered a decision sustaining the trust left by Mrs. Katherine M. Garcelon of Oakland, California. After long and expensive litigation, the wishes of Mrs. Garcelon will be carried into effect and three-fifths of the sum will be used to establish a hospital in Oakland and two-fifths will revert to Bowdoin College which will receive about $500,000.

The Bartram memorial library of botanical books has been presented to the library of the University of Pennsylvania.

Mr. R. F. Balk, of Cincinnati, has given to the University of Cincinuati his collectiou of specimens of natural history said to be of considerable value.

A new bacteriological laboratory has been built for the University of Melbourne at a cost of $20,000.

The Department of Geology of the University of Chicago had three parties of students in the field during the past summer. Two of these parties were in Wisconsin, one during July and oue during August, while the third party was in the West, along the line of the Great Northern Railway. The principal stops made by the third party were at Midvale and Lake McDonald, Montana, and at Lake Chelan in Washington. A trip was also made into the Kootenai region of British Columbia. Each party was iu the field four weeks, and the total number of students participatiug was between thirty and forty.

The registration at Yale University is 2,474, a decrease of 43 as compared with last year. The Sheffield Scientific School has, however, an increase of 36 students.

Sir Michael Foster has been reelected member of the British Parliament, representing the University of London, without opposition; Sir John Batty Tuke has been returned under the Universities of Edinburgh and St. Andrews also without oppositiou.

The daily papers report that eight of the former professors of the reorganized University of Havana are to receive peusions of $1,200 a year each during the term of the military occupation.

The Rev. Dr. Robert Sheppard, professor of history aud political economy at Northwestern University, has been appointed president of the University.

Edward M. Paxson, ex-Chief Justice of the Supreme Court of Pennsylvania, has been elected president of the Medico-Chirurgical College in Philadelphia.

William T. Horne and Albert T. Bell, fellows in botany in the University of Nebraska, have resigued, the former to accept a position iu Kadiak, Alaska and the latter an instructorship in the High School of Lincoln, Nebr. Mr. Horne expects to make collections of the flora of Kadiak Island for study on his return a year or two hence. Miss Daisy F. Bonnell, of the class of 1899, has beeu appointed fellow in botany.

Professor J. W. Freley has been appointed acting president of Wells College.

Dr. Spencer W. Richardson, lecturer on mathematical physics at University College, Nottingham, has been elected principal of Hartley College and professor of physics.

SCIENCE

Friday, November 2, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE RELATION OF EDUCATED MEN TO THE STATE.**

I should fail to do justice to my own feeling did I not pause for one moment to acknowledge the kindly greeting which has just been extended to me at the beginning of my life among you. For the words of encouragement which have been spoken, for the assurance of cooperation and support, for the cordial personal welcome, I am more grateful than I can say. The response to such words and to such welcome is not to be made at this time and at this place. It can be given only in the years of service which lie before us.

In choosing a subject upon which I might address you to-day, I have felt strongly influenced to call to your attention certain conclusions which touch upon that great interest which is the common bond which brings us together to-day—the education of men.

It was my fortune some years ago to pass from a university place to that of an executive office of the general government; to go from the work of training students to a corps of men who are recruited almost wholly from the ranks of college graduates. In the attempt to secure for the government service men of the best training, the relation

* Inaugural Address of Dr. H. S. Pritchett, late Superintendent of the U. S. Coast and Geodetic Survey, as President of the Massachusetts Institute of Technology.

of the educated man to the government, whether as an employe or as a citizen, has been a matter of immediate practical consideration.

In such a position one studies the output, if one may use that term, of our universities and of our colleges from a different point of view from that which the teacher occupies. He is measuring the college man in comparison with other men, from the standpoint of his ability to do things and not from the standpoint of the knowing how to do things.

The two points of view are very different, and it is for this reason, as well as for the strong interest which I have in the subject, that I have deemed it not entirely without interest to say a word to you at this time concerning higher education in relation to the government, and more particularly to consider the part which educated men are to-day taking, and ought to take, in government, the obligations of the higher institutions of learning to the State, and finally to discuss briefly the question whether these obligations are being fairly and honestly and intelligently met.

There is a saying which is current in the student talk of German universities to the effect that of those who enter the university doors one-third breaks down, and one-third goes to the devil, but that the remaining third governs Europe. Such expressions are oftentimes more apt than true; yet, on the other hand, they sometimes represent popular conviction more correctly than formal tables of statistics, just as a bit of floating straw shows the direction of the current more truthfully than the powerful cruiser.

Unfortunately, it is not easy to subject such a statement to accurate examination. The statistics of the unsuccessful are necessarily far more incomplete than the statistics of those who attain prominence. The devil keeps no books, so far as I know; or if he does, they are not open to examination of the student. But it requires only a limited study to show that the last part of the statement is certainly true, at least so far as Germany is concerned. The educated man, trained in either the university or polytechnicum, governs Europe to-day.

No one connected with the government of the United States in any executive capacity can fail to see that the government of this country is also passing rapidly into the hands of educated men. The population of the country at this time is approximately 76,000,000 of people. The number of college trained men is perhaps less than one per cent. of the population. From this small percentage, however, are filled a majority of the legislative, executive and judicial places of the general government which have to do in any large way with shaping the policy and determining the character of the government.

Not only in the ordinary positions of the government service is this true, but the government is calling more and more frequently upon the educated man for the expert service for which his training is supposed to fit him, and this not only in the relation of scientific experts, but in all other directions in which the government seeks the advice and the assistance of trained men.

On the other side of the Pacific a commission of five American citizens has undertaken the most delicate, the most difficult, doubtless the most thankless task in the establishment of civil government to which any group of our citizens has ever devoted its unselfish efforts. It is a significant fact that a majority of that commission are college professors.

In the service of the government, as in all other fields where intelligence and skill are factors, the educated man is displacing from the higher places the one who has no training or who has a poor training. Whether wisely or unwisely, whether for good or ill, it may be accepted as a fact that the government of this country is passing rapidly into the hands of the educated man.

It is a matter of the highest practical importance to inquire whether the man who is coming into this power is worthy of it, and whether the training which he has received in the college or in the technical school is given with any purpose of fitting him for this trust.

Before approaching this question it may be well to call to mind the attitude of the government of the United States and of the State governments toward higher education and toward scientific investigation.

Notwithstanding the crudeness of our legislation, it is still a fact that Congress and the State governments of the United States have been generous in gifts to higher education and to scientific work. The gifts of the general government have come from the sale of public lands; to the separate States has been left, heretofore, the power to lay taxes for the support of institutions of higher training.

It is difficult to bring together the data for a trustworthy statement of the value of all these gifts, but they aggregate an enormous amount. At the present time the Federal government is devoting more than ten millions annually to the work of the scientific departments of the government. At the very beginning of organized government in this commonwealth the question of education was one of the first with which the State concerned itself.

The principle of State aid to higher education, then recognized, has been since that time accepted by the general government and by every State government. In New England, Harvard and Yale and other foundations of higher learning are now dependent upon private endowments; yet almost every one of these has at one time or another received State aid. Harvard was in reality a State institution, having received from John Harvard only £800 and 320 books.

And while the more generous gifts to New England colleges have come from private sources, they have never hesitated, in time of emergency, to come before the representatives of the people and ask for assistance—these petitions have never been disregarded by the State.

The American republic may fairly claim to have adopted, and to have followed out Macaulay's motto: 'The first business of a State is the education of its citizens.' In no land and at no time has the State responded so quickly and so generously to the demand for higher education as in the United States of America, and during the last half-century.

If this aid had been rendered by an individual, if one could imagine the spirit of the whole people, both State and National, incarnated in a personal intelligence, which should take cognizance of the obligations of those whom the State had befriended, I can imagine that one of the most direct questions which such an intelligence would address to those who direct the education of the youth would be:

"I, representing the whole people, have given you freely of my national domain, the heritage of the whole people; I have founded and supported colleges and universities and technical institutions. What direct return has been made to me for this assistance, and have those who control the training of the youth kept in view their obligations to me and the dignity and the needs of my service?"

The question is a perfectly legitimate and a perfectly fair one. And while it is easy to answer it in generalities, it is not so easy to give a reply of that definite sort which shall lead somewhither. The subject is too large and has too many ramifications to be discussed in full on this occasion.

Perhaps the best I can do is to call attention to the importance of the inquiry itself, and to the obligation which exists for a definite and full, and most of all an honest answer. In addition, I shall endeavor to point out certain directions in which, to my thinking, the ends of government have been well served in our system of education, and certain others in which, it seems to me, we need improvement.

It may be stated as a general result that the State (using that term to characterize both the general government and the State governments), has been well served by the institutions of higher learning. It can be shown satisfactorily that in the main these institutions have not only served the general purpose of the diffusion of knowledge among men, that they have trained men in such a way as to make them more effective in the pursuit of their own fortunes, but also that they have given back to the State men well trained to serve it.

In a very real sense, education and science have been handmaidens of the State, for they have not only thrown their friendly light upon the problems of statecraft, but their children have been more numerous and more helpful in the service of the State than any other group of citizens. It may be said with perfect truthfulness that the higher institutions of learning have well earned from the State the assistance they have received.

Notwithstanding this general outcome, there are certain directions in which the State may reasonably demand additional results. It is to be remembered that the State represents, as does no other agency, the whole people, and in considering the obligations due the State, and the best method of discharging them, the institutions of learning are attempting to serve, in the most direct and, at the same time, in the broadest way, the whole body of citizens.

One thing which the government has a right to expect of those educated in the higher institutions of learning is a decent respect for the service of the State.

I am sure I express the sentiment of all men of serious purpose who have stood in executive places in Washington when I say that there is no greater source of discouragement to those who are honestly striving for good administration than the facility with which good and honest and intelligent men will ascribe the worst motives to those in government office.

Again and again a man of pure life and of high purpose, who has accepted a post under the government, discovers with infinite pain and surprise that the silliest charge against him is accepted, not only among the idle and the curious, but by those upon whose support he had most counted. This tendency is not peculiar to our time or to our nation. It is a part of 'that touch of nature which makes the whole world kin,' a kinship as universal as it is detestable.

One cannot think of the failure to discriminate between the dishonest few and the honest many, of the courage brought to failure by the wellnigh universal suspicion, of the unmerited pain, from Washington's day to this, inflicted by the careless judgment of men's motives, without recalling the words of Edmund Burke: "It is very rare, indeed, for men to be wrong in their feelings concerning public misconduct; as rare to be right in their speculation upon the cause of it. I have constantly observed that the generality of people are at least fifty years behind in their politics. There are very few men who are capable of comparing and digesting what passes before their eyes at different times and occasions so as to form the whole into a distinct system. But in books everything is settled for them without the exertion of any considerable diligence of sagacity. For which reason men are wise with but little reflection, and good with little self-denial in the business of all times except their own."

Let me say that no man can be brought into contact with the actual machinery of our government, can mingle with the men who make our laws, who interpret them and who execute them, without gaining not only a wholesome respect for the service of the State, but also a reasonable hopefulness for the future of our institutions.

So far as my judgment goes, there are few conventions of men brought together for any purpose in which the average of intelligence and of honesty is higher than in the American Congress. It goes without saying that its members are influenced by personal considerations, by social ties, by all the things which move men—in other words, they are human—but it is a gathering of men who honestly desire to do the right thing.

It is the fashion to speak of the honesty and the intelligence of the good old days when the republic was young and when statesmen were pure, and to deprecate the decadence of the present day. Such talk is the purest nonsense. The general intelligence of the body of Congress is higher to-day then it ever was, and its conscience is quite as acute. Unfortunately, the work of quiet and serious men receives little attention from the public, although these men count enormously in the actual work of legislation.

In the executive branches of the government as well, one will find a quality of service to command respect. There are incompetents in greater numbers than one could wish, but the quality of men entering government service is improving steadily since the civil service law has made it possible for men of education and energy to find a career there. And, notwithstanding the half-hearted service of the few, it is true that the government receives quite as much of devotion and of unselfish service as one can find in the ranks of those engaged in private business.

The government of the United States is honestly conducted. Its condition furnishes to those who know it best the basis of a rational optimism as to the future of democratic institutions. In its service men of education should find, in increasing numbers, careers of the highest usefulness and of the highest dignity.

Another quality of the education given to the youth upon which the State has a right to insist is its catholicity. The State makes no distinctions in the matter of education. It aims to make its highest training accessible to the humblest as well as to the most aristocratic.

No system of education is a good one for a free State in which the students and graduates of its institutions of learning get out of touch with the great body of their fellow-citizens. Such a lack of contact between the men of education and those who lack education brings about a feeling of distrust as between men of two distinct classes. Under such circumstances the educated man is likely to lose the perspective concerning social facts and tendencies, and becomes suspicious and narrow; to feel that the country is fast going to the bad, and that the advice and the service of the educated man are not properly appreciated.

One of the practical results of this feeling has been that the college man has not always realized that he was to take his place side by side with the man who had no college education; that he must expect to begin where the uneducated man begins, and that his education was not a mark to distinguish him from other men, but a training which ought to enable him to do his part of the world's work better than the man who lacked this training, but that he was not one whit better, nor was he to receive the slightest consideration because of his better opportunity.

It is the protest againt this feeling of superiority, whether real or imagined, which is at the basis of most of the objections now offered to a college education as a preparation for the active work of life. The feeling is voiced in the following words from the late Collis P. Huntington. In a magazine article published just before his death, entitled 'Why Young Men should not go to College,' he says: "Somehow or other our schools which teach young people how to talk, do not teach them how to live. It seems to me, that slowly, but surely, there is growing up a stronger and stronger wall of caste, with good, honest labor on one side and frivolous gentility on the other."

In so far as this charge is true that a college training tends to make those who receive it a class apart, and prompts them to make extravagant demands, in just that proportion is it a fair criticism of our system of instruction. We have a right to expect that the college trained man, more than any other, shall be tolerant and patient. That he shall understand, as no one else can, that truth and honesty and virtue belong to no age and to no nation; that they are the property of no party, and no sect, and no class. And we have a right to expect that, realizing this, he shall have wholesome views regarding human nature. If the college atmosphere does not encourage all this, then the college atmosphere needs quickening.

In the great wave of enthusiasm for education which has been the remarkable social phenomenon of the last quarter-century's progress it was, perhaps, to have been anticipated that some mistakes of this kind would occur. When education—and a very narrow conception of that term—was proposed as a cure for all ills, it was natural that some should assume that the man who received a certain training should also receive, *ipso facto*, special consideration in the world.

How far this criticism has been justified in the past I do not feel able to say. I do believe, however, that the college spirit of to-day is wholesome and catholic; that the men in the higher institutions of learning are in closer touch with the great body of mankind than ever before, and that men who go through college and take their places in the world do so in accordance with the rules of common-sense.

But beyond all such questions, and including them all, is another in which the state is vitally interested, and this is the quality of citizenship which our system of education is adapted to produce. This I hesitate to approach, since to discuss it is to open the whole qüestion as to what the object of education is and what subjects should be taught to accomplish that object.

It is the old question which has been discussed for 2,500 years, and never more vigorously than during the past decade. However we have improved the methods, we have certainly never been able to state the questions involved more clearly than the old Greeks. Listen to Aristotle; he writes:

"What, then, is education, and how are we to educate? As yet there is no agreement on these points. Men are not agreed as to what the young should learn, either with a view to perfect training or to the best life. It is not agreed whether education is to aim at the development of the intellect or of the moral character. Nor is it clear whether, in order to bring about these results, we are to train in what leads to virtue, in what is useful for ordinary life, or in abstract science."

Could any modern state more aptly or in fewer words than these, the questions which have formed the basis of discussion during the last quarter-century among those interested in education, with the marked difference that education for the development of character is less talked about.

Is education to have for its object the training of the intellect, or is it to aim at the development of character, or is it to undertake both objects? And if the character is to be developed, what are the formal means which are to be used in this development?

These questions have been asked anxiously since systems of education had their beginning. In our day they seem to have settled themselves, so far as the practical efforts of the universities and colleges are concerned, by a process of exclusion. It is tacitly assumed, at present, that education —like all other training—has for its end the acquisition of power. In order to acquire power quickly the whole effort in modern education is directed toward the training of the intellect.

There is no disputing the fact that the educated man has in the world a higher potential by reason of his education. Is it equally true that he has, on the average, a stronger and higher type of character? Is the college man broader in his sympathies, more tolerant, more courageous, more patriotic, more unselfish by reason of his life in the walls of a university or of a technical school? Are the men who come each year, in ever-increasing thousands, from the college doors, prepared to shoulder more than their proportionate share of the burdens of the State and of the country, or are they provided with a training which will enable them to more easily escape its obligations?

Let there be no misunderstanding in this matter. Whatever our system of education is doing or is leaving undone in the development of character among its students, the State is saying in terms which are becoming every day more emphatic, this:

However desirable it is to train the mind when it comes to the service of the State (if, indeed, the same is not true in all service), character is above intellect. It is vastly important to the State that her servants shall be quick, keen-witted, efficient, but it is absolutely necessary that they shall be honest, patriotic, unselfish; that they should have before them some conception of civic duty and proper ideals of civic virtue. Give me men, intellectual men, learned men, skilled men, if possible, but give me men.

It is the old story, this cry. It is the lesson which every age preaches anew to the age about to follow. Shall we ever learn it? Will it ever come to pass that in our system of education the development of character will go hand in hand with the development of the intellect; when to be an educated man will mean also to be a good man?

Probably no one looks upon Plato's Ideal Republic as the basis for any effort in practical politics, nevertheless it ought to be true that civic virtue should be a part of the life and of the environment of our seats of learning, and that men, along with the training of their minds, should grow into some sort of appreciation of their duties to the State, and come to know that courage and patriotism and devotion rank higher in this world's service than scholarly finish or brilliant intellectual power.

When we look back on our own history as a nation we can but realize that in the crises of our national life this truth has been forced home to us. In the darkest hours of the revolution it was the courage, the never-failing patience, the unselfish devotion, in a word, the civic virtue of George Washington which was the real power upon which the people leaned.

In the agony of our civil war, when the fate of the nation trembled in the balance, the character of Abraham Lincoln, his devotion, his hopefulness—above all, his knowledge of and his faith in the plain people—counted more than all else in the decision. Neither of these men was the product of university training, nor did they grow up in an academic environment; but each had learned in a school where devotion to the State was the cardinal virtue. When next a great crisis comes, no doubt there will be a Washington or a Lincoln to meet it, but will he come from a university?

When Washington came toward the close of his life he thought deeply over the dangers of the new State and the necessity for the cultivation of a spirit of intelligent patriotism. As a best means for inculcating this spirit he conceived the idea of a great national university. One of the main objects of this university was to afford to the youth of the country the opportunity for 'acquiring knowledge in the principles of politics and good government.' The idea was a splendid one, and while the need for a national university no longer exists (unless, indeed, one is needed to teach the principles of good politics), Washington's idea that the university is a place which should train not only the intellect, but the character; that it is a place where the student should find an atmosphere adapted not only to the development of accurate thought, but also to a wise and tolerant spirit; that in the university he should gain not only intellectual strength, but also a just conception of the duty to the State, was a right view.

And until this is recognized; until we bring into our college life and into our college training such influences as will strengthen the character as well as the intellect; until the time shall come that the educated man shall by reason of his training be not only more able than his untrained neighbor, but also more patriotic, more courageous, better informed concerning the service of the State, and more ready to take up its service; until such a spirit is a part of our system of higher education, that system will not have served the ends which education should serve in a free State and for a free people.

And in this connection I cannot refrain from a reference to the aim of those who founded the Institute of Technology, and to the conception of duty which they have impressed upon the institution. The recognition of the value of exact science as a means for the training of mind came slowly. Even after it did come men were slow to recognize the value to the race of the results of science. The spiritual side of scientific research is a matter which even to this day men are slow to comprehend, notwithstanding the powerful effect which it has had during the last generation upon the thought and upon the conscience of the world.

"Newton was a great man," writes Coleridge, "but you must excuse me if I think it would take many Newtons to make one Milton."

Forty years ago there were few men in this republic who appreciated in any clear way the value of science in the training of men. To William B. Rogers, and to those who labored with him, belongs the credit of anticipating the value of this training and the demand for it.

But outside and beyond all these considerations of fitness and of practical results attained, they also impressed upon the institution certain principles which are dominant in its life to-day. One of these concerns itself with the very situation and environment of the institute.

The Institute of Technology has its roots in the same soil which supports the industrial life of the city and of the nation. Its contact with the practical side of life is immediate and real. It not only draws its strength thence, but expresses as only that can which has a real and vital connection, the aspiration of those who labor in science for the upbuilding and the improvement of civilization. The Institute of Technology not only aims to serve the people: it is itself of the people.

One of the lessons which the study of

exact science leaves with the student is the necessity not only for exact work, but for a high ideal. Science is satisfied with nothing short of perfection, and this principle when it pervades a body of men comes to govern and control the spirit in which their work is done. No better heritage can be left to any institution than that which has been faithfully handed down to you, namely, in education it is not sufficient to be merely accurate, but it is necessary to hold fast to the highest ideal.

Once this idea gains control of a student life, that student will undertake faithfully and courageously whatsoever duties lie before him, whether they concern his professional life, his social life or his country's service.

Let me add, in conclusion, a word of personal greeting, speaking as one may when he addresses those who have come together, drawn by a common interest.

In the name of the corporation, and of the faculty, and of the students of the Institute of Technology, I thank those who represent here other institutions for your presence on this occasion. Your coming is not only a source of pleasure, but of encouragement to us, and helps to emphasize that spirit of common interest and of common helpfulness which ought ever to mark the relation of those who have to do with education. The Institute of Technology extends to you, and through you to the institutions which you represent, the assurance of its cordial good feeling.

Two of those who sit upon this platform the President of Lehigh University and the President of Harvard came from the faculty of the institute. This fact gives to your presence here an additional element of ininterest, and we extend to you a special greeting.

To Lehigh University in the sturdy work which she has done and is doing, for the courage with which she has not hesitated to face difficulties, we extend our warm congratulations.

To our near neighbor, the oldest and largest of American universities, we offer most hearty greeting. We rejoice in the greatness and in the strength of Harvard University, and take courage in the thought that we join hands with her to-day—as an elder sister—in a work not only for this city and for this commonwealth, but for humanity.

Gentlemen of the Corporation: In accepting the responsibility which you have this day formally invited me to share with you, I do so hopefully and with full confidence in you, in this community, and in the future. There is no greater work committed to men's hands than that to which we are called.

As I think of those who have preceded me in this place, when I call to mind their splendid services to the institute, to the commonwealth and to the country, I accept this work with a feeling of great humility, but with the earnest hope that through our common effort the institution may grow not only in strength, but in usefulness; not only in facilities for work, but in the better understanding of what work means, and that it may ever seek to lead in all that concerns the rational and helpful teaching of applied science.

Gentlemen of the Instructing Staff: For the cordial welcome to your number I am most grateful. I come to you with no new message and as the herald of no new gospel. The same spirit of work and of devotion which has been the glory of your body in the past must be our source of strength for the future.

In all that leads to the uplifting of technical education in the development and extension of the work of the institution, in the suggestion of new means by which it can minister more directly to the work of education upon the one side, and to the promotion of scientific research upon the other, I ask your hearty cooperation and assistance. An institution, like an individual, must grow in its experience, in its appreciation of truth, in comprehension of the meaning of art and of science and of life, if it is to minister to a growing civilization. The inspiration which shall stand back of this growth must rest, in large measure, upon your zeal and your effort.

Alumni of the Institute: To each of you has been mailed an invitation to this gathering. These missives have gone to every country and to every climate. Some are at this moment being borne on the backs of men or in snow-sledges to the interior of Alaska, to be read months hence amid the winter snows. Some will be read in the tropics, under the glare of a summer sun.

Your alma mater would gladly have welcomed each one of you this day to her fireside, though the fare be frugal and the feast modest. Since this cannot be, let her invitation carry at least this suggestion: How farsoever from her halls your path may lead, it can never take you beyond the circle of her affection.

The institute is proud of the men it has sent forth, and she counts upon their loyalty and their devotion. She invites your counsel, your suggestion, your friendly criticism, your help. And while she listens with willing ear to every voice which rings true, she asks you to remember that no greeting so thrills her as that which comes up from one of her own children who is doing a man's work in the world.

Students of the Institute: In a more real sense than any other body you are the Institute of Technology. As such I salute you to-day, and assure you not only of my earnest wish for your advancement and your success, but also of my wish for your friendship and for your help. I prefer to think of such an institution as that in which we work together, not as an empire governed by the few, but as a republic in which faculty and students alike are charged with the government of the whole body.

I congratulate you on taking up the study of engineering, using that term in the broadest sense. There was never a more opportune time to enter such work, nor was there ever a period in the history of our country when the trained engineer had open before him so attractive a field.

This is the day of the trained man, and to him the responsibilities and the rewards will go. To the American engineer a whole series of new problems of the highest interest have in recent years been presented. Railways are to be built, canals are to be cut, a whole empire of desert land is to blossom under his hand. The Pacific Ocean and the countries which border upon it are to be the theater of an enormous development.

Cables will be laid, cities will be developed, the tropics will be subdued. In all this development the engineer, the trained engineer, is to play a rôle that he has never yet played since civilization began. The next quarter-century is to belong preeminently to him, and in all these world problems and world enterprises you are to share.

May I hope that in your preparation you may bear in mind as your ideal of an engineer, not only one who works in steel and brick and timber, but one who by the quality of his manliness works also in the hearts of men; one who is great enough to appreciate his duty to his profession, but, likewise, and in a larger and deeper sense, his duty to a common country and to a common civilization. H. S. Pritchett.

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*ENGINEERING EDUCATION IN THE UNITED STATES AT THE END OF THE CENTURY.**

There is no reason apart from custom why any special significance should be at-

* Address of the President of the Society for the Promotion of Engineering Education.

tached to the arbitrary measure of time that we call a century. The main course of history is not much affected by the arbitrary transition from one century to another. But custom has established the turn of the century as an appropriate time to record the past and forecast the future. Since to this Society is entrusted more than to any other agency the future of engineering education in this country, and since we as a nation have risen out of the Monroe doctrine and our isolation, and have taken our first steps to become one of the number of great powers that assume to direct the course of civilization and decide the destiny of the rest of the world, and since this nation largely through the work of the engineer is making rapid progress toward the commercial conquest of the world—the present seems an auspicious occasion on which to study briefly the progress of engineering education.

The century just closing has witnessed a marvelous development in all matters relating to education. Probably the most remarkable feature of the educational history of the century is the extension of the opportunities of an education to the common people as a right. To-day there is nothing in this country so free as education, and the United States is far in the lead of foreign countries in school attendance, about one-fourth of the school population of the world being Americans.

At the beginning of the century there were thirty colleges in the United States with about 3,000 students, while to-day there are 472 collegiate institutions with 155,000 students. But the mere increase in numbers is not the most significant feature. The colleges then were of a lower grade than most academies to-day. This is the explanation of the frequent mention in the biographies of men of that time that they graduated at the age of 15 or younger. The remarkable improvements in the methods of instruction have been both a cause and an effect of the popularization of education.

Another important element in the development of education in America has been the munificent contributions of individuals and of governments to the cause of education. The movement in this direction, during the closing years of the century, has been at a rapidly accelerated rate, and is therefore an element of great promise for the future.

Technical education, the application of the sciences to the needs of man, is a growth entirely of this century. Apparently the first technical school in the world was the École Polytechnique in France, established in 1794 to train men for the artillery and engineering corps of the army. The U. S. Military Academy was founded in 1802, and for more than thirty years thereafter was the only organized agency for engineering education in America. For three-quarters of a century a surprising proportion of the graduates of this institution practiced engineering in civil life, not because the education there given was what would now be called engineering instruction, but because it was the best preparation for engineering practice that could then be obtained. Apparently this fact has been overlooked alike by friendly and unfriendly critics of this noted institution. In 1825 at Troy, N. Y., was organized the first institution in the world for giving instruction in engineering not military. Apparently at the time of the founding of this institution the term civil engineering had not been coined, the word engineering being synonomous with military engineering.

For thirty years after the establishment of the engineering school at Troy, *i. e.*, from 1825 to the close of the civil war, only four engineering schools were founded, of which only two were really entitled to the name engineering. During this time the engineering schools gave but little technical instruction; most of the so-called engineering part of the course consisted of mathematics and elementary science.

In 1862 Congress passed an act giving to the several states public lands for the benefit of 'instruction in the arts and sciences relating to agriculture and the mechanical arts.' Shortly after the close of the civil war many of our engineering schools were organized under this act. Never was there a movement more timely or more successful than this, since it has resulted in the establishment of sixty-four technical colleges—at least one in each state and territory. Fifty of them give instruction in one or more branches of engineering.

The number of institutions at present giving instruction in engineering is shown in Table I. The institutions are classified

TABLE I.

Number of Institutions giving Instruction in Different Branches of Engineering in 1898–99.

Institutions.		Number Offering Courses in						
Grade.	No.	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	E.
Class A	30	27	21	21	5	8	2	2
Class B	27	24	17	14	10	6		
Class C	20	12	12	7	5	1		
Class D	9	1	9	5				
Class E	3	3	2	2	1			
Total	89	67	61	49	21	15	2	2

with reference to their requirements for admission according to the scheme presented by the Committee on Entrance Requirements—see the annual report of the Society for 1896, pages 103–4. The report of the Committee includes 110 institutions, but the writer concludes from a careful study of their catalogues that at least twelve of these have no engineering course. The writer has received no report from seven of the United States institutions listed by the Committee, nor from the two Canadian engineering schools.

Table II. shows the number of students in the several branches of engineering for the year 1898–99; and Table III. the number of graduates for the year 1899. These data were collected from the institutions for this purpose. A few schools were not heard from, but in each case they were small ones having few, if any, engineering students, which fact probably accounts, in some cases at least, for their failure to report. Therefore, Tables II. and III. may be considered as representing the total number of

TABLE II.

Number of Students in Different Branches of Engineering in 1898–99.

Institutions.	Number Offering Courses in							
	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	S. E.	Total.
Class A	1359	1579	1405	245	366	54	19	5027
Class B	794	435	510	313	20			2072
Class C	463	919	299	298	3			1902
Class D	10	337	156					503
Class E	41	23	27	4				95
Total	2667	3293	2397	860	389	54	19	9679

engineering students and graduates for the year 1898–99. During the decade 1889–99 the number of students increased from 3,043 to 9,659, or 317 per cent.; and the graduates increased from 483 to 1,413, or 242 per cent. However, in this connection averages are misleading, since the rate of growth for the different courses vary greatly. For

TABLE III.

Number of Engineering Graduates in 1899.

Institutions.	Number of Graduates in							
	C. E.	M. E.	E. E.	Min. E.	Arch.	Nav. A.	S. E.	Total.
Class A	210	299	252	43	54	9	1	868
Class B	143	52	77	14	2			288
Class C	56	89	27	21				193
Class D	5	37	11					53
Class E	5	3	3					11
Total	419	480	370	78	56	9	1	1413

example, from 1889 to 1899 the increase of civil engineering graduates was 56 per cent., and of mechanical 117 per cent.; while the entire growth in electrical engineering is practically a matter of the past decade.

Table IV. presents some interesting statistics as to engineering education in comparison with the so-called three learned professions—theology, medicine and law. The data for the first three columns of Table IV. were compiled from Bulletins 7, 8 and 9—'Professional Education in the United States'—published by the University of the State of New York.

The data in Table IV. concerning the length of high school course required for admission to engineering schools must be regarded as only roughly approximate. It is difficult for one not acquainted with all the facts to determine from the catalogue just what the requirements are; and the need of these data was not foreseen when those in the preceding tables were asked for. Farther, the value of a year of high-school study varies greatly even within the limits of a single State, which adds materially to the difficulty of making a correct general statement as to the conditions for admission.

There are several matters in these tables that invite discussion. For example: 1. Why do so few institutions offer instruction in architecture?—see Table I. Why so few students in architecture?—see Table II. 2. The significance of the fact that more than half of the engineering students are receiving their education in Class A institutions, *i. e.*, those having the highest requirements for admission—see Table II. 3. Are the number of graduates more or less than required to fill the ranks of the profession? 4. Is the number of engineering graduates greater or less, in proportion to the demands of the profession, than law and med-

TABLE IV.

PROFESSIONAL EDUCATION IN THE UNITED STATES. DATA FOR 1898–99.

Item.	Theology.	Law.	Medicine.*	Engineering.
Number of Schools,	165	86	156	89
Growth since 1878,	32%	144%	82%	21%
Number of Instructors,	1070	970	6416	
Number of Students,	8099	11833	26088	9659
Growth since 1878,	87%	294	142%	516%
Number of Graduates,	1193	3110	5725	1413
Requirements for Admission,				
College Degree,	43%	2.3% Require College work.		
Completion of Junior Year,	2		0.7%	1.1%
Completion of Freshman Year,	11			
4-yr. High School Course,		3.5%	8%	4.1
3-yr. " " "	11	14	2	24
2-yr. " " "	4	13	3	51
1-yr. " " "	1	9	62	17
Common " "	11	30	19	
None or Indefinite,	17	28	1	4
Total Reported,	100%	100%	100%	100%
Length of Course,				
4-yr. Course,	24%		91%	98%
3-yr. Course,	70	51%	6	1
Less than 3-yr.,	4	43	3	1
Total Reported,	98%	94%	100%	100%
Average Length of Yearly Session,	8 mo.	7¼ mo.	7 mo.	8.7 mo.

* Does not include Dentistry, Pharmacy and Veterinary.

icine? 5. Do the data in Table IV. justify the usual classification of schools of law and medicine as post-graduate and engineering as under-graduate? In this connection the fact must not be overlooked that some of the students in law and medicine have more or less college training before entering upon their professional course, and the same is true in engineering but to a much less extent. Time forbids a consideration of these questions here.

But statistics can not represent the most important developments in engineering education in the last third of the closing century. Immense strides have been taken in both the methods and the scope of instruction. At the close of the civil war there were nominally only six institutions giving any grade of instruction in engineering; and for ten or fifteen years thereafter, the engineering instruction offered by the best institutions is hardly deserving the name in comparison with that offered by many institutions at the present time. During this period some of the engineering instruction was practical and not scientific, and some was scientific and not practical; but none of it consisted of the principles of scientific engineering, nor of the relations of the sciences to engineering problems. Text-books were few and poor. The equipment of the schools was inadequate. Then the student went to college to learn details of practice and to fill his notebook with formulas; he was reluctant to give his best efforts to the acquisition of fundamental principles and to the development of the ability to see straight and to reason correctly. Happily now all that is changed, and the schools of America are now offering unexcelled facilities for the acquisition of the fundamentals of an engineering education, and the students are laboring heroically to ground themselves in the principles of scientific engineering.

Twenty-five years ago practitioners had doubt as to the value of a technical training for young engineers, and distrusted the engineering graduate; but now general managers and chief engineers prefer technical graduates, since they have been trained in scientific methods of working, and have a knowledge of the fundamental principles underlying all engineering practice, and look out upon the world of truth from the view-point of a man of science. The national engineering societies now give credit for training in the engineering school toward the requirements for admission to membership. The most cordial relations now exist between practitioners and the schools of engineering. Within recent years, largely if not mainly through the influence of the technical schools, engineering has ceased to be traditional and has become scientific.

The technical school met with no welcome from the older colleges and universities. In the beginning the devotee of the non-technical subjects was not willing to admit the study of engineering as being upon the same high plane as that of literature, history and philosophy. Now all who know the facts are ready to admit that the engineering student secures greater advancement during his college career than any other undergraduate. This result is due to the definiteness of the aim of the engineering student, to the stimulus of professional preparation and to the nature of the study.

One of the most important advances in engineering education has been the introduction of the laboratory method of instruction. Now all the better institutions have extensive and well-equipped laboratories fitted up especially for experimental work, in which the student receives instruction of the very highest value. In this respect our American schools are unrivaled in the world. In Europe, particularly in Germany, are some notable and well-equipped engineering laboratories which have done much to advance engineering science, but which are used by experts in research and commercial work and not for purposes of instruction. Although our engineering laboratories are maintained primarily for purposes of instruction, a considerable amount of research work is performed in them.

The curriculum of the engineering college at present consists of about 10 per cent. of English or modern foreign language, usually the latter; 30 to 40 per cent. of indirect technical studies, as mathematics, physics and drawing; and 50 to 60 per cent. of technical work. The tendency is to make the engineering courses as completely professional as are courses in law and medicine. Experience has shown that it is impracticable to teach culture subjects in a course with strongly marked technical tendencies, since the student devotes all his time to the latter and neglects the former. Very recently there has been a tendency to force some of the indirect technical subjects, as advanced algebra and trigonometry, into the preparatory school to get more time in the engineering college for directly technical subjects. The effect of this is still further to curtail the culture studies of the engineering students by eliminating these subjects from the preparatory course.

A number of institutions offer post-graduate instruction in engineering; but the number doing post-graduate work in engineering is less than that in science or literature. In 1898–99 at twenty-three leading institutions the average per cent. of graduate to undergraduate students in non-engineering departments was 9.94; in the engineering departments, 2.3; or, in other words, the per cent. doing graduate work in non-engineering courses is more than four times greater than in engineering courses. In the above computations graduates doing undergraduate work are considered as undergraduate students But few, if any, Americans now attend European engineering schools, for it is generally conceded that the American schools, in equipment, methods and scope of instruction, are superior to any European schools, at least for American engineers. There are at least three reasons for the relatively small number doing graduate work in engineering:

a. In many cases, if not in a majority, the chief object of post-graduate study is to secure the preparation necessary for teaching the subject. In many branches the whole range of study, both undergraduate and post-graduate, is purely academic and can be obtained in college environments better than anywhere else. But in engineering the prospective teacher must secure a personal acquaintance with the conditions of practice, which can be obtained only by engaging in actual engineering work. In short, the future teacher of engineering prefers to engage in practice after graduation rather than to return to college halls for further study.

b. Probably many students pursue an engineering course chiefly because it promises an early means of securing a livelihood, and not unnaturally feel that they can ill afford the means required for post-graduate study. Others who are financially able to continue collegiate work beyond graduation are more anxious to have a part in the activities of the outside world than to pursue post-graduate study. At present the demand for engineering graduates is such that in both of these classes, at least those that are really deserving, find little or no difficulty in obtaining remunerative positions in practical engineering work. The engineering college is attempting to give a professional training to its graduates, and it is not surprising that they are anxious to apply in practice that which they have been studying in college. A few years ago many engineering students were unable to resist the seductive offers of positions in actual practice, and left college before graduation. Recently the demand has been almost exclusively for graduates, and now a much larger proportion than formerly stay to graduate. When the competition of young engineers for positions becomes greater, as it doubtless will, probably a greater proportion will be willing to engage in post-graduate study. But this element may not become very effective in increasing the number of engineering students seeking advanced collegiate work, for some of them may prefer to serve for a time after graduation as apprentices at comparatively low salaries. Already there are evidences of a considerable tendency in this direction.

c. The third reason for the less number of post-graduate engineering students is by far the most important. Ordinarily post-graduate study is primarily intended for independent research work; and this is properly so, for after a young person has been under the direction of tutors for fifteen or twenty years, it is time that he should attempt to blaze a road for himself. If this research work is really original, it will inspire the highest ambition of the student, and will secure his utmost efforts. This class of work will always attract. But departments of study differ greatly in the opportunities for original research. The less fully developed branches of study doubtless have many unsolved problems waiting for investigation, and some of these are such that a recent graduate may reasonably be expected to solve them, or at least to collect part of the data required for a subsequent solution. Engineering post-graduate study offers fewer opportunities for this class of work than many other departments of collegiate work, because of the more fully developed state of most branches of engineering knowledge. Again, the nature of the investigations in many departments is such that they thrive better in a college atmosphere than anywhere else. This is not true, in general, of engineering investigations. Finally, and most important of all, original research in most departments of study is carried on only because of the enthusiasm of the investigator or by public or private benevolence; while in engineering most of the research work is done in connection with practical work at the expense of individuals or corporations or municipalities having a direct financial interest in the result. Many engineers devote a large part of their time to original research work, and nearly all practicing engineers have more or less of such work. The life of an engineering student before and after graduation is much more nearly continuous than that of a student in most other departments. The ambitious engineering student knows that, shortly, if not immediately, after graduation, he can secure actual engineering practice of high educational value, and many choose positions chiefly with reference to the value of the experience to be obtained. The salary, the educational value of practical experience, the possibility of promotion—all draw the engineering student away from post-graduate study. In other words, the study of engineering is essentially graduate work, and there will probably never be any considerable number who will pursue engineering studies beyond the present four-year course. But there are sufficient reasons why adequate provisions should be made for the competent and ambitious few who seek truly graduate instruction in engineering.

All the preceding is intended to show in rough outline the present state of engineering education, and particularly the rapid growth. The present phenomenal rate of progress promises still larger things for the future, and lays upon this Society important responsibilities in directing the future development of engineering education in America. In this connection there are several matters which invite the careful attention of individual members of this Society, and possibly are worthy of official action by the Society itself.

1. Is any general movement for increasing the requirements for admission desirable? The standard has been rising quite rapidly within the past five years, particularly in mathematics, English and foreign languages; but even now comparatively few of the engineering departments of the universities have as high requirements for admission as the literary departments. Is this justifiable?

2. Is it wise to require advanced algebra and trigonometry for admission to the engineering courses? Is it wise to require prospective students to take these subjects in secondary schools to the exclusion of subjects in science, literature or history? Will the forcing of these subjects into the curricula of the secondary schools handicap them in discharging their just obligations toward students who are not seeking an engineering education? Which subject can the preparatory school teach the better? Which school will teach the mathematics the better?

3. At some institutions a considerable number of engineering students have had previous collegiate training. Can anything be done to increase their number?

4. Engineering courses have become so highly specialized that frequently students of one course receive no instruction in the fundamental technical subjects of a closely allied branch of engineering. This practice is burdensome upon the school and is probably not of the highest advantage to the student. But the colleges are not likely to retrace their steps, and therefore the highly specialized course is a condition to be reckoned with. Should anything be done to prevent further specialization? Some students correct the defects due to high specialization by remaining a fifth year and pursuing the allied course. Can anything be done to increase the number who do this?

5. The engineering course of to-day is so loaded with required technical and scientific work that the student has little or no time to cultivate those subjects, indefinitely, but not inappropriately, called the humanities. Engineering students, more perhaps than any others, need training in such subjects. Those who follow the other learned professions deal constantly in their technical work with the relationships of their fellow men, while the engineer in his professional work deals mainly with the inanimate world. The engineer has little opportunity to come into intimate relations with men either through the study of history, economics and sociology, or through personal contact. The engineer usually possesses strong character, sound judgment, thorough knowledge of his business; but frequently because of a lack of that knowledge which other men consider essential in a liberal education, he is ranked as a relatively uncultivated man, and therefore is unable to exercise the influence his training justifies, and fails to secure the reward his abilities merit. Can the instructors in engineering create in the mind of the engineering student such a hungering for a knowledge of the humanities that he will secure it after graduation by private study and personal intercourse?

Such, then, are the conditions and the problems of engineering education as we step into the twentieth century. The present conditions have been determined largely by the engineering colleges themselves in advance of the demands of the engineering profession and of the general public, and often in opposition to such demands. Chiefly through the influence of the engineering college the engineering profession has developed during the past third of a century into a truly learned profession. There was never a time in the history of the world when the questions of general education were more carefully considered than at the present; and there was never a time when this country was more concerned with the work of the engineer than now. The nation, just awakening to a consciousness of its power and responsibility, is taking its place among the nations of the earth, and is seeking to decide the destiny of the peoples of the earth. We are now sending our manufactured products to all parts of the world, and if we are to have part in the commercial conquest of the earth, it will be because of the ability, the foresight, the wisdom of our own engineers. The only agency seeking to prepare engineers for their work is the engineering college. Their work in molding and directing the engineering education of the future will be no less important than in the past. They enjoy the respect and confidence of the public, and a still wider field of influeuce and responsibility lies open before them. May the deliberations of this Society continue to be a source of strength and inspiration to the engineering colleges. May the engineer of the twentieth century have better technical training, broader culture and nobler aspirations. May the profession of engineering come to occupy a still higher position in the esteem and respect of the public.

Ira O. Baker.

University of Illinois.

PROGRESS IN IRRIGATION INVESTIGATIONS.

The organization and objects of the irrigation inquiries of the U. S. Department of Agriculture have been partly explained in an earlier number of this Journal.* Congress at its last session increased the appropriation for this work from $35,000 to $50,000.

It was realized at the outset of these investigations that a basis of settlement of the controversies over rights to water for irrigation purposes, which are very frequent and acute in the arid region, where the supply of water is limited, must be reached before it would be wise to attempt to greatly increase the use of water for irrigation. The uncertainty of water rights and ignorance as to the amounts actually needed for successful agriculture led irrigators to claim more water than they could possibly use, frequently more than the natural supply yielded, and encouraged extravagant rather than economical use of water. It was for this reason that the Department directed attention first to the collation and publication of information regarding the laws and institutions of the irrigated region in their relation to agriculture, and a number of bulletins dealing with this phase of the subject, as well as with general irrigation practice, have been published. At the same time it was realized that an exact knowledge of the water requirements of cultivated plants at different stages of growth and under varying conditions of soil, climate, etc., is fundamental to an economical, rational practice of irrigation. It was therefore determined that one of the two main lines of work undertaken should be the collation and publication of information regarding the use of irrigation waters in agriculture as shown by actual experience of farmers and by experimental investigations. It was decided, however, that the strictly scientific studies provided for in this plan could be more intelligently pursued after the actual practice as regards irrigation in the various localities where it is already engaged in had been ascertained. Inquiries having the latter object in view were planned and put into operation on a comprehensive scale. The results of the

* Science, 11 (1899), p. 798.

first year's work along this line are given in a bulletin* on 'The Use of Water in Irrigation,' which is now in press. This bulletin deals with the methods in use in the arid States in the distribution and use of water in irrigation, and gives a large number of measurements made to determine the 'duty of water' and the losses from seepage and evaporation in canals; and discusses the methods by which the water supply may be more effectively and economically applied to crops. It contains papers discussing the results of the year's investigation by Elwood Mead, expert in charge; tables for use in measuring water and diagrams showing use, by Clarence T. Johnston, assistant; and reports and discussions of irrigation investigations in different localities by special agents Thomas Berry, Colorado; W. M. Reed, New Mexico; W. H. Code, Arizona; W. Irving, California; R. C. Gemmell and George L. Swendsen, Utah; D. W. Ross, Idaho; Samuel Fortier, Montana; and O. V. P. Stout, Nebraska. The bulletin is illustrated by numerous plates, diagrams, and maps showing the location and character of the investigations made. It is probably the most complete collection of data on the 'duty of water' in irrigation which has ever been published, and is especially valuable because it is based on measurements, systematically planned and synchronously made, of the amount of water actually used on a large number of farms in widely separated portions of the arid region.

Among the important facts brought out in the report is the enormous loss of water from canals and reservoirs by seepage and evaporation. From actual measurements made it is estimated that in some cases at least the loss from these causes might be so far reduced by better methods of construction and management as to double the area at present irrigated by the canals. Attention is also called to the large losses occurring when water under small head is spread in a thin layer over soils heated to the high temperatures common in some parts of the arid region, and to the great advantages of rotation in the use of water as contrasted with the wasteful methods encouraged by the common system of contracts which gives to the irrigator the right to a uniform and constant flow of water. The results, therefore, not only furnish the basis for improving methods of irrigation already in use and for framing more equitable laws, but it is believed that they indicate more clearly the lines along which strictly scientific inquiries may be most successfully directed.

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 86, pp. 248.

Owing to the absolute dependence of agriculture upon irrigation in the arid region, attention was first directed to the irrigation problems of that region, but the work is being extended to the eastern or so-called 'humid' portion of the United States, for the necessity for irrigation is by no means confined to the region west of the hundredth meridian. The aggregate loss from total or partial crop failure as a consequence of periods of drought in the region where the rainfall is usually considered sufficient for the needs of agriculture is far greater than is generally realized. This fact is clearly brought out in a report by E. B. Voorhees on 'Irrigation in New Jersey.'* This bulletin discusses the need of irrigation in New Jersey, reports the results of experiments at the experiment station at New Brunswick and elsewhere in New Jersey during 1899 to determine whether irrigation during periods of drought is a profitable undertaking, and gives descriptions and statements of cost of a number of small irrigation plants in New Jersey.

The rainfall records of Philadelphia for 70 years are cited to show the frequency of injurious droughts:

* U. S. Dept. Agr., Office of Experiment Stations, Bul. 87, pp. 40.

"In 62 years out of 70 there was one month in the growing season from April to August in which such a marked deficiency occurred as to cause a serious shortage of crop, and for the same period there were 39 years in which the deficiency extended throughout two months, while in 21 years it extended throughout three months, or in 30 per cent. of the years included in this record there were three months during the growing period in which the average rainfall was deficient one inch or more. It is thus observed that a wide series of crops would be likely to suffer in more than one-half of the years for which the record is available, while a still larger number would suffer in nearly one-third of the years, for it must be remembered that even a slight deficiency in one month may result in a serious reduction in yield and consequent loss, if it occurs at a time when the crop is making its largest development."

Some idea of the extent of the losses occasioned by such periods of drought may be gained from Professor Voorhees' estimate that the loss to the hay crop of New Jersey alone from the drought in May and early June, 1899, was $1,500,000, while small fruits, vegetables, and other crops were also seriously affected.

"In 1897 and 1898, years of abundant rainfall in April and May, the yield of hay [at the Station] averaged 2.65 tons per acre. In 1899 it was a fraction over one ton, owing to the deficiency of rainfall in April and May—at the low price of $10 per ton, a loss for the 25 acres of over $400. The yield of crimson clover forage for 1897 and 1898 was 8.5 tons per acre; in 1899 the yield was but five tons, or in a good year the yield was 70 per cent. greater. The deficiency in the rainfall at the critical period was alone responsible for this difference in yield. . . . Oat and pea forage in 1897 and the early seeding of 1898 averaged six tons per acre; in 1899 the yield was but 3.3 tons."

In experiments at the Station with small fruits the increase in yield due to irrigation was as follows: Blackberries, 1,038 quarts per acre, worth $93.42; raspberries, 329 quarts per acre, worth $32.90; currants, 311 quarts per acre, worth $31.10. The results of similar experiments in other parts of the State with a variety of crops confirmed those obtained at the Station. These results show beyond question that supplemental irrigation under such rainfall conditions as those noted above is a profitable undertaking, especially on fruits and garden crops. Since the rainfall conditions described may be considered typical of the whole eastern half of the United States, the conclusions reached regarding the profitableness of irrigation are believed to be generally applicable to the agriculture of that region.

W. H. Beal.

*REMEASUREMENT OF THE PERUVIAN ARC.**

In 1889 the question of the remeasurement of the Peruvian Arc was brought before the International Geodetic Association by the Delegate of the United States (Professor George Davidson, Assistant Coast and Geodetic Survey) who suggested that France should have a prior right to execute this work in consequence of the first measure having been made by her savants, members of the French Academy in 1736–43. Circumstances prevented any active work until 1898, when the discussion of the subject was renewed in the same Association as the result of a motion offered by the Delegate of the United States (Mr. E. D. Preston, Assistant Coast and Geodetic Survey).

The Association voted in favor of the proposition to remeasure the Arc and the French Delegates undertook to bring the matter to the attention of their government and to have an examination made, so that they could report to the next meeting of the Association at Paris during the present year.

Captains Maurain and Lacombe of the Geographic Service of the French Army left Paris in May, 1899, and remained in

* The information is derived from the *Comptes Rendus, hebdomadaires des Seances de l'Académie des Science*, No. 26, June 25, 1900 (page 1740), and the *Bulletin de la Societé de Géographie*, No. 7, July 15, 1900 (page 1).

Ecuador from July to November of the same year, successfully accomplishing in this time the reconnoissance for the new work.

Unfortunately all the marks left in the old work have been destroyed, even the base monuments having been demolished. According to the plan proposed the Arc of Quito which will replace the Arc of Peru covers 6° of latitude nearly double the length of the old Arc.

Fifty-two triangulation stations will be occupied. Three fundamental astronomical stations have been selected, one near Quito and one at each extremity of the Arc, where latitude and longitude will be determined. Other determinations of latitude will be made at intermediate stations to permit a study of the deviation of the vertical. Three base lines from eight to nine kilometers in length will be measured.

One is situated near Riobamba about the middle of arc and is to be connected with sea level by levels of precision which are expected to determine its elevation with an error not exceeding a few centimeters. Two verification base lines will be measured, one near each end of the Arc. Observation of gravity and magnetism will be made, and studies of topography, geology and other subjects of natural science undertaken. Quito possesses an observatory with modern instruments, in charge of a French astronomer, situated only fourteen minutes of latitude south of the equator, at an elevation of 3,000 meters above sea level.

To execute the measure of the new equatorial arc and complete the complementary studies that should be made in connection with it, it is estimated that five geodesists should devote four years of uninterrupted labor to this work. The difficulties to be overcome will tax the courage and scientific devotion of those upon whom the honor of its execution may be bestowed.

I. W.

SIXTH ANNUAL MEETING OF THE BOTANICAL SOCIETY OF AMERICA.

THE sixth annual meeting of the Botanical Society of America was held in New York City, June 26 to 28, 1900. For the reading of papers the Society met in joint session with Section G of the American Association for the Advancement of Science, June 28th, in Room 502, Schermerhorn Hall, Columbia University. The meeting of Section G was called to order by the Vice-President, Wm. Trelease, who announced the arrangements for the joint session and called B. L. Robinson, president of the Society, to the chair. The retiring president, L. M. Underwood, then read his address—'The Last Quarter: A Reminiscence, and an Outlook.' The full text of the address has already been printed in SCIENCE.

Following is the program of papers presented:

'The Significance of Transpiration': C. R. BARNES.

'Relationship and Variability of the Adirondack Spruce': CHAS. PECK.

'Nuclear Studies on Pellia': B. M. DAVIS.

'On the Structure of the Stem of *Polytrichadelphus dendroides*': MRS. E. G. BRINTON.

'Observations on the group Yucceæ': WM. TRELEASE.

'Spermatogenesis in the Gymnosperms': J. M. COULTER.

'The Pollen Tube, and Division of the Generative Cell, in Pines,' by invitation of the Council: MISS M. C. FERGUSON.

'On the Homologies and Probable Origin of the Embryo-Sac': GEO. F. ATKINSON.

'Observations on Leisonia': CONWAY MACMILLAN.

'Thigmotropism of Roots': F. C. NEWCOMBE.

'Starch in Guard Cells': B. D. HALSTED.

'Coenogametes': B. M. DAVIS.

'The Development of the Archegonium, and Fertilization in the Hemlock Spruce,' by invitation of the Council: W. A. MURRILL.

'The Causes Operative in the Formation of Silage,' by invitation of the Council: H. L. RUSSELL and S. M. BABCOCK.

'A Closed Circuit Respiration Apparatus,' by invitation of the Council: H. L. RUSSELL and S. M. BABCOCK.

The officers for the ensuing year are: *President*, B. D. Halsted; *Vice-President*, R. A. Harper; *Treasurer*, C. A. Hollick; *Secretary*, G. F. Atkinson. *Members of the Council*; B. D. Halsted, B. L. Robinson, R. A. Harper, C. A. Hollick, G. F. Atkinson, C. E. Bessey, F. V. Coville.

An important step was taken by the Society in appointing a committee to consider the best means of realizing the purposes of the Society, 'in the advancement of botanical knowledge,' as defined in the constitution. Among other things this committee will consider the uses to which the accumulating funds of the Society may be put. The committee will report at the next annual meeting of the Society.

Geo. F. Atkinson,
Secretary.

SCIENTIFIC BOOKS.

PUBLICATIONS OF THE EARTHQUAKE INVESTIGATION COMMITTEE—IN FOREIGN LANGUAGES, NUMBERS 3 AND 4 TOKYO—1900.

There is one science which the Japanese have practically made their own. Blessed or cursed (according to how you look at it), by the frequent occurrence of earthquakes, and blessed (certainly) by the presence of a large number of able and enthusiastic students of physical science, Japan has become within twenty years a vast seismological laboratory in which seismic phenomena are being studied as they never were before. Indeed, modern seismology had its birth there, and there it has been and is being most carefully nurtured. About twenty years ago there were in Japan a considerable number of foreigners employed as professors of engineering, geology, physics, etc., and of necessity they became interested in the one characteristic natural phenomenon, the unpleasantly frequent manifestations of which none of them will ever forget.

In the observational study of earthquakes one of them, Professor John Milne, F.R.S., now residing on the Isle of Wight, then Professor of Geology in the School of Engineering, exhibited a zeal and enthusiasm together with untiring patience and fertility of resource beyond all others, and mostly through his efforts the 'Seismological Society of Japan' was organized. In its organization and maintenance the foreign professors received the hearty cooperation of the Japanese officials in the University and out of it. For several years the society issued annual volumes of Proceedings, the great value of which has been everywhere recognized. The gradual and finally almost complete withdrawal of foreigners from the educational work of the country resulted at last in the suspension of the active work of the society, but happily this did not occur before the Japanese had come to realize fully the importance of the work it had done, and, indeed, not until a number of their own young men had been fully trained to carry that work on.

In 1891 official interest in seismology took definite form in the passage of a vote by the Chamber of Peers or House of Lords, upon the initiative of one of its members Dr. Dairoku Kikuchi, now President of the Imperial University of Japan. By a large majority the Cabinet was urged to appoint an 'Earthquake Investigation Committee,' and on June 25, 1892, an Imperial Ordinance was promulgated establishing such a Commission and naming its members. Its duties were defined in a general way in this Ordinance and the payment to its members of a small annual salary was authorized.

The Committee prepared a very elaborate and comprehensive scheme of work which it has followed pretty closely up to the present. The President is Dr. Kikuchi, and Dr. Omori, of the Faculty of Sciences of the Imperial University, is Secretary. There are nearly thirty members, including professors of pure and applied sciences in the University, engineers, architects, etc.

It has been the wise practice of the Committee to publish its principal proceedings and most important papers in foreign languages and of the two under review No. 3 is mostly in the French language and No. 4 is in English.

One of the principal objects of the Committee is to consider the practical aspects of seismology with a view to a lessening of the loss of life, damage to buildings and other structures, as far as may be found possible, so that much attention has been given to studies of resistance of materials of construction and to the effect of actual earthquakes upon existing structures of various kinds. No. 3 consists, in the main, of an account of a most elaborate and interesting experimental investigation of some of the more important physical properties of bricks, and briquettes of cement, mortar, etc., especial attention being given to those qualities which give strength and stability against seismic disturbance. This report is by S. Tanabe, a member of the Committee, and is a valuable contribution to our knowledge of the subject.

There is also, in the same volume, a short description by B. Mano of a machine by which a platform or 'shaking table' is made to oscillate as it would during the passage of a series of seismic waves, the horizontal and vertical motions being produced independently, each capable of adjustment as to amplitude and frequency, so that almost any kind of disturbance may be imitated, except minute earth 'tremors.' The motive power consists of two steam engines, and as many as 270 oscillations per minute may be maintained. There is also a brief note on the damage suffered by tall chimneys in the earthquake of June, 1894, and in that of October, 1893. In the case of the latter 230 chimneys in all were examined, ranging in height from 30 feet to 150 feet. Of these 53 suffered serious injury, the highest percentage being for those between 60 feet and 80 feet high. The volume closes with a paper in English on 'The Scope of the Volcanological Survey in Japan,' by Dr. B. Koto, member of the Committee, who has undertaken to study the geological aspects of the seismic problem. For the great majority of earthquakes the author rejects the volcanistic hypothesis and adopts the *tectonic*, believing that seismic disturbances are intimately related to the process of mountain building.

No. 4 begins with a condensed statement on the 'Construction of Earthquake-proof Wooden Buildings.' Although very brief, this paper is of great interest, and as nearly all houses in Japan are built of wood it must prove to be of great practical value. Rules for the making of joints, the construction of frame work and especially of roof framing are given with sufficient detail and clearness (aided by numerous illustrations), and particular emphasis is placed on the character of the foundation. Even ordinarily constructed wooden houses are damaged less by earthquake disturbances than structures of brick or stone, and when built according to the rules and suggestions given in this paper they will be generally immune except during unusually violent shocks. The worst part of an ordinary Japanese house, from the seismic standpoint, is the heavy tile roof, and the importance of making the roof as light as possible, and of having the tile securely fastened, is dwelt upon in this compendium. The use of iron plates and straps, with bolts, in the formation of joints is strongly advised. It may be interesting to note here that the new palace for the use of the Prince Imperial is to be a modern 'structural steel' affair, the material having been obtained in this country, and in the structural plans, made by American architects, especial care has been exercised to provide against damage by earthquake. By the use of numerous cross-braces and 'ties' it is made to resemble somewhat a huge steel basket which, although it may, and indeed, should be capable of a little elastic yielding, can never be seriously injured in any imaginable seismic disturbance.

Anent the generally damaging effect of earthquakes upon brick buildings Dr. F. Omori discusses the records of a number of disturbances as shown by two of Professor Ewing's horizontal pendulum seismographs, one of which was set up on a wall of a large brick building, known as the Engineering College, and the other on the ground near by. Ten earthquakes were thus observed and recorded, none being very strong. The results appear to show that in comparatively long period oscillations, that is to say those somewhat above .5 second, there was no noticeable difference in amplitude between those of the second story of the brick building and those of the ground, while with quick period motions the movement was greater on the wall of the building than on the ground, the average amplitude of the former being double that of the latter. Omori calls attention to the fact that injury to brick buildings by earthquakes is nearly always much greater in the upper stories than in the lower, and he illustrates this by photographs of the condition after the great earthquake of 1891 of the Aichi Cotton Mill and the Post and Telegraph Office, both at Nagoya. The Charleston earthquake in 1886 afforded many examples of this.

Omori furnishes two very interesting notes on the great earthquakes of 1891 and 1894. These are the most violent disturbances that Japan has suffered in recent years, and that of October 28, 1891, was probably at least equal in intensity to any other earthquake of which we have authentic record. Its greatest activity was displayed in the provinces of Mino and Owari. The land area disturbed was about 250,000 square kilometers, and as the mean radius of propagation was about 520 kilometers the total shaken area was about double the area of the whole empire. The total number of people killed was 7,000, and 80,000 houses were entirely destroyed. The fact that only one life was lost for every 11 houses destroyed illustrates (when compared with the effects of earthquakes in brick- and stone-building countries) the greater safety of wooden houses which, even when destroyed, afford ample warning and time to enable their inmates to escape.

The actual motion in this earthquake was nowhere satisfactorily recorded on seismographs, but Omori has made up for this lack as far as possible by the observation and calculation of a large number of overturned stone lanterns and tomb stones, noting as well those not overturned. The horizontal acceleration necessary to overturn is calculated by West's formula which is very simple and unquestionably very nearly correct under the conditions considered. It is

$$a = \frac{x}{y} g$$

in which g is the acceleration due to gravity, and x and y the horizontal and vertical coordinates of the center of gravity of the column, the origin being the edge about which overturning takes place. It is assumed that the motion is entirely horizontal which introduces no sensible error except for points, very near the epifocus. Results are computed for about sixty points in the disturbed area, and in several instances a horizontal acceleration of over 400 centimeters per second, is shown. The seismograph at Nagoya, one of the principal points shows that the complete period of the principal vibrations was about 1.3 seconds, and as the maximum acceleration there was 260 cm., it follows that the range or amplitude of vibration of the earth particle was between 23 cm. and 24 cm.

The earthquake of June 20, 1894, although the most violent experienced in the Tokyo district since 1855, was much less strong than that of the Mino-Owari district referred to above. Twenty-six persons were killed and 171 were wounded. Fortunately the disturbance was very satisfactorily recorded by a strong-motion seismograph at the Seismological Observatory in Tokyo. The actual amplitude of horizontal motion was 7.3 cm., and the maximum acceleration was about 100 cm. per second. In the greater shock of 1891 this was probably not less than 1,000 cm. per sec. per sec.—being a little greater than the acceleration due to gravity.

Dr. H. Nagaoka has a very interesting paper on the experimental determination of the elastic constants of rocks, leading to important conclusions relating to the velocity of seismic waves. From observations made in Italy and also in Japan, Omori has concluded that the velocity of the first tremor is generally as high as 13 kilometers per second, which is surprisingly great, the principal shocks usually showing a speed of 3 kilometers to 4 kilometers per second.

Nagaoka discusses the conditions under which the very high velocities may occur, and one cannot avoid being impressed with the great value of earthquake observations as a means of ascertaining the nature and conditions of the interior of the earth.

The greatest part of No. 4 consists of an account, by Omori, of an elaborate series of 'Experimental Studies upon Fracturing and Overturning Columns,' and this is not only one of the most interesting, but perhaps the most important paper in the whole series. In this investigation the 'shaking table' already referred to was made use of and columns of considerable dimensions and various materials were used. Many were of dimensions equal to those of the stone lanterns and tombstones made use of in computing the intensity of the Mino-Owari earthquake. The accelerations necessary to overturn were also calculated by West's formula, and it is surprising to see how closely they accord with those obtained from the graphic record of the 'shaking table.'

Because the contents of these volumes are made up of carefully conducted observations of actual and very strong earthquakes, for the first time recorded by means of satisfactory instruments, together with elaborate experimental investigations of important related phenomena, and because all these results are fully discussed with remarkable skill and keen scientific insight, it is, perhaps, not too much to say that they constitute the most valuable contributions yet made to the literature of seismology.

Even those who know the men who are doing this work, through familiar association and often close personal relations, cannot avoid a feeling of astonishment at the extraordinary performances of a people whose contact with the world at large has been only that of the present generation, and with whom the so-called civilized nations have been strangely and unreasonably unwilling to treat on a basis of equality until within three or four years. When I reflect that seismology is only one of the many sciences in which in original research the Japanese are well in the front rank, and this, too, without the inspiring example of an ancestral Galileo, Newton, La Place, Humboldt or Franklin, I wish to do figuratively what I have done many times actually—I take off my hat to an oriental nation that in peace or in war need ask no odds of Europe or America.

T. C. MENDENHALL.

Rapports présenté au Congrès International de Mécanique appliquée ; Exposition Universelle de 1900. Tome I. CH. DUNOD, Editeur. Paris. 1900. 8vo. Pp. 546.

The various cougresses of the Paris Exposition of 1900 are now bringing out their published papers and discussions, and the royal octavo volumes of the Congress of Applied Mechanics are finely illustrative of the character of the work performed at these conventions and of the manner in which it is to be published. Of the innumerable books printed relating to the Exposition, these are the most valuable and, to the serious student of that great cyclopedia, most interesting. The 'questions' discussed in Vol. I. are nine in number : 'Organization of Works'; 'Organization of Mechanical Laboratories'; 'Mechanical Applications of Electricity'; 'Hoisting Apparatus'; 'Hydraulic Motors'; 'Sectional Boilers'; 'High-speed Engines'; 'Heat Motors'; 'Automobilisme.'

The first topic is discussed by M. Touissant, who presents a study of the manufacturing establishment generally, and Mr. Dickie, who gives a most interesting account of the organization and administration of the Union Iron Works of San Francisco, the birthplace of the famous battleship *Oregon*, and the source of innumerable steamships, steam-engines and pumping and winding engines, and of mining and manufacturing machinery in enormous amount. M. Boulvin discusses the organization of mechanical laboratories, and his valuable paper is introductory to that of Dwelshauvers, who describes that of the University of Liège, organized by him after years of struggle and strife with the ultra-conservative administration of the University and the Government. The evolution of the mechanical laboratory in America, as an element of technical instruction, is described by Thurston and includes papers by a number of representatives of engineering schools in the United States, giving accounts of an equal number of the most extensive and interesting laboratories of that class in our country. The development of the laboratory of applied mechanics and its accessories as a means of instruction, primarily, and as an item in the equipment of the technical school and as an essential element of the curriculum, was first effected satisfactorily in the United States. The European schools are now coming to the same plan in rapidly increasing numbers, often modeling after our own in both equipment and methods of employment. Another instructive division of this subject is discussed by Commandant Mengen, who tells of the organization and the details of equipment of the laboratory of the ordnance department of the French army, which is very extensive and complete and is evidently conducted in a modern and fruitful manner.

The third 'question' includes a paper by Dr. Kennelly, describing mechanical applications of electricity, especially as observed in the United States. Messrs. Delmas and Henry discuss the use of the current in hoisting machinery and in the establishments of public works departments. M. Bassères discusses the fourth question and especially the work of the 'Compagnie des Fives-Lillie.' Hydraulic motors, as constructed in Switzerland, the home of that form of prime mover, 1889–1900, are reported upon by M. Prazill. M. Rateau writes of their theory and construction as illustrated by contemporary practice in general.

Dr. W. F. Durand takes up the sixth topic and gives an account, complete and exact, of the water-tube boilers employed in the United States, and M. Brillié also discusses the 'chaudieres a petits éléments,' their classification, efficiency, operation, with characteristic thoroughness. MM. Lefer and Lecornu write of high-speed engines and of regulators, the former including the ancient Greek type, just revived, the steam-turbine. 'Thermic Motors,' apparently only intending to include the gas-engines in the class, are the subject of valuable papers by MM. Diesel, who reports on his own invention and construction; by Mr. Donkin, who discusses those employing the waste gases of the blast furnace; and by M. Witz, the well known authority on that class of motor, who tells of gas-engines of large power employed in metallurgy. The final discussion in this volume is that of 'automobilisme,' by MM. Rochet, Cuénot and Mesnager.

All the papers here published have special value in their several departments of applied science and some of them are extremely important. The contributors to the volume are usually French writers and practitioners of authority; a few are American, and we recognize the name of but one German in the list. The German government took a leading part in the Exposition and German exhibitors abounded, as did German visitors; but the scientific men of Germany, in this department, at least, seem to have held aloof.

The book is a fine sample of the style and finish of the French official document. In paper, type and finish, and illustration, while not what a French critic would consider illustrative of a high class of bookmaking, it is, for its place and purpose, most excellent. In many cases of condensation and of abstracting, on the part of the editors, as especially in the case of the descriptions of American mechanical laboratories, where the original contained very extensive and very extensively illustrated details, the necessary work of merciless condensation has been, in the main, very well done. The translations from the English into the French are, so far as a first rapid survey would indicate, excellently performed. The collection will have great and permanent value to the engineer and to the professor of engineering, as well as to all having interest in these divisions of applied mechanics.

R. H. Thurston.

The Antarctic Regions. By Dr. Karl Fricker. Translated by A. Sonnenschein. New York, The Macmillan Company. 1900. Pp. xii + 292. With many maps and illustrations. Price, $3.00.

In view of the widely extended interest in the Antarctic region at the present time, it would seem as though it would almost be unnecessary to say that this was a timely production. It is, however, not the only requisite of a book that it is timely. Its substance should be of a high character and its form of statement should be clear. In this particular case, the historical portion of the work is good, but its character is marred by too great condensation. This fact alone would make it a poor book to put in the hands of the general reader, who is looking for pleasure as well as for information. Even if the original work was intended for the scientific man, the translator should have had tact enough to recognize the fact that it was not at all necessary to follow the German construction of the sentences too closely. A good translation should take some account of the spirit of the language into which the work is to be rendered, and not make its perusal a burden by the introduction of too many parenthetical sentences. Of course in such a work as this much new information is not to be expected, and the major portion of the book is given over to a historical summary of the various voyages to the South Polar region. But that is no reason for closing this section of the book with the following sentence (p. 131):

"This survey indicates what parts of the Antarctic regions have principally been visited, and sums up how much or how little has been achieved by each attempt. It will be the aim of the subsequent pages to gather into a whole the results of all these explorations so far as their fragmentary nature renders such a task possible."

This portion of the book is followed by a description of the 'conformation of the surface and geological structure,' which would be a very acceptable piece of work were it not for the cumbersome English sentences which defy all attempts to parse them.

A splendid opportunity to offer a summary of our knowledge of the climate, the structure of the ice, the fauna and flora is simply annihilated by such sentences as the following (p. 250): 'The non-melting of the snow is of necessity accompanied by a change in its transformation.'

Again, scientific men do not usually speak of a species of animals being 'extirpated,' as they are said to be on pages 270 and 273.

The maps and charts are, however, the redeeming features of the book. They form a very interesting collection of illustrations and are worthy of a better fate than burial in such ponderous and heavy verbiage.

It is also to be regretted that in giving a list of books, articles and maps upon this subject, no attempt was made to make the list as nearly complete as possible. In these days of careful bibliographical work the preparation of such a list would have been a comparatively easy task. Furthermore, a labor of this character would have been very much appreciated by the scientific world, and it is a pity that it was not done.

By what has been said above, it is not intended to produce the impression that the book is without merits. It will be a useful compend for a person who desires to become acquainted with the leading facts in connection with Antarctic investigations, but it will never be a book of popular interest. In the scientific summaries too little has been given to satisfy the scientific man, and it is therefore evident that there is still an opportunity left for a book which will satisfy these conditions.

WILLIAM LIBBEY.

Physiology for the Laboratory. By BERTHA MILLARD BROWN. Boston, Ginn & Co. 1900. Pp. viii + 167.

A Syllabus of Elementary Physiology with References and Laboratory Exercises. By ULYSSES O. COX. Mankato, Minn., Free Press Printing Co. Pp. viii + 167.

If one were to judge by the number of books on 'Practical Physiology' that appear yearly, it would seem that the long-hoped-for day had come in which Physiology had become a laboratory study in all academic grades from the grammar school to the university. Even if it fulfills the ideal of its author only, each book in this field, if well done, is to be welcomed, for it means at least an attempt in the right direction.

Of the two books now before us Miss Brown's is the more modest. In less than 150 pages there are given the essential experiments in a course in Vertebrate Physiology, presumably for the high school or normal school. A chapter on the cell and one on the bacteria are added. The matter is in large part purely physiological, but the dissection of the various organs is included. Vivisection is excluded except the slight amount that is involved in a study of reflex action in the brainless frog. The directions simply point the way, and the chosen ground is well covered. A few corrections should be made: The chromosomes are said to 'be scattered through the protoplasm'; epidermis is 'the outer, dead skin'; the expanded portion of the external ear is misnamed the 'concha,' while the reflex character of the knee-jerk is settled by requiring the student to trace the course of the nerve impulse.

The book by Mr. Cox consists of a syllabus with references to reading, and a series of laboratory exercises. The syllabus is a detailed but crudely expressed classification of the conventional subject-matter of Physiology, of which students could make little use. The references are chiefly to well-known American and English text-books, most of which are good but some of which are sadly out of date. The laboratory exercises partially cover the conventional elementary ground, but are inferior to those of Miss Brown and of other authors. Unfortunately the book is marred by slovenly English, colloquial expressions and typographical errors.

Frederic S. Lee.

Physiology, illustrated by Experiment. By Buel P. Colton. Boston, D. C. Heath & Co. 1900. Pp. xiii + 386.

This book is intended as a 'Briefer Course' of Mr. Colton's 'Physiology, Experimental and Descriptive.' As an elementary text-book for secondary schools it can be recommended. It contains an unusually large amount of matter, concisely, briefly, and upon the whole attractively presented. It is preeminently physiological and hygienic as distinguished from anatomical. Its language is not overburdened with technicalities. Its directions for practical work are limited, but this is excusable in view of the many satisfactory laboratory books now in existence. Most of its figures and diagrams are excellent.

The treatment of the subject of alcohol, while fairly moderate as compared with that of some writers of text-books, is somewhat intemperate in its use of adjectives. At the beginning of the chapter devoted to this subject the bald statement is made that 'alcohol is not a food.' At the close of the chapter it is allowed, on the authority of well-known quoted writers, that 'technically it may be called a food.'

Frederic S. Lee.

FOLK-LORE IN BORNEO.

Dr. William Henry Furness 3d, had privately printed an attractive little volume called 'Folk-lore in Borneo: A Sketch,' in which is given a brief report of an ethnological field that has acquired a new interest because of the recent discoveries made in the group of islands to which Borneo belongs. The influence of a tropical environment is noted by the author in the Kayan myth of creation, which he narrates as a 'purely Bornean' product, and contrasts it with the Dyak account of the genesis of the race, wherein he discerns Malay influence. Among the interesting pages of the book are those which tell of head-hunting, 'the one ruling passion of the people.' The tradition of its origin is given, and the author thoughtfully remarks: "It is not unfair to infer from this tradition that they have a crude, germinal sense of the barbarity of their actions, in so far as they think it necessary to invent an excuse to palliate that savage love of trophy-hunting which seems inborn in mankind." And he points out how the native beliefs concerning the five peculiar regions in 'the land of departed spirits' tends to conserve the practice of the head-hunting 'rite.' Among the many interesting subjects touched upon are the connection between the Pleiades and agriculture; the omen birds and the devices the people practice to avert bad luck; the function of fire as a 'go-between of man and the birds'; and the glimpses of a river cult among these natives. The illustrations really illustrate the text; they are admirably selected, and the pictures of old and young, men and women, inspire confidence as types, as they are without exaggerated peculiarities. The book is a welcome addition to the literature of folk-lore.

A. C. F.

DISCUSSION AND CORRESPONDENCE.

NEWSPAPER SCIENCE.

To the Editor of Science: I have had so much satisfaction in the review and criticism recently published in Science, of Mr. Tesla's magazine article on 'Human Energy' that I cannot avoid making public acknowledgment of my appreciation of its justice and timeliness, especially the latter. Is it not the imperative duty of men of science to do what the author of this review has done, more frequently than they have during the past ten years?

Within this decade there has been an enormous decrease in the cost of publication and especially in the expense of illustration, and this has brought about a deluge of reading matter of such infinite variety and general worthlessness that the formation of a society for its systematic suppression is worthy of serious consideration. With the daily newspapers it has been distinctly an era of sensationalism.

A reporter for a daily paper recently declared that he was required by his chief to 'furnish at least two sensations a week.' Nearly all the more respectable and conservative magazines have yielded somewhat to this demand. The general reading public has recognized in an indistinct and uncertain way that much that is wonderful in this 'wonderful century' is due to scientific discovery, and it is apparently hungry for easy exposition of scientific work. It seems to like, at any rate it is largely fed upon, science of the 'head-line' variety, and those who can furnish this sort are in great demand. Unfortunately there are a few men, fortunately not many, who have done and are doing really excellent scientific work who are ready to cater to this morbid appetite, and there are many others, merely 'hack' writers with neither knowledge or reputation, who find it easy to imitate them. The result tends to dull the scientific sense and corrupt the judgment of the great majority of readers. What we see in print concerning what we do not understand we almost invariably accept as true unless it violently opposes our prejudices or accepted theories, and the general public, therefore, is in a very receptive mood towards announcements of scientific discoveries and accomplishments. That this is taken advantage of to reach the purse of the public no one can deny, and it is impossible not to find certain very respectable and otherwise conservative journals largely responsible for losses of thousands of dollars by comparatively poor people through stock subscriptions in schemes believed to be backed by scientific men. It is no valid defense to say that the editors of these journals were imposed upon, for if they were they need not have been. Other journals, including some daily papers, know very well how to avoid such imposition and have the courage to do it. It appears to be accepted as a fundamental principle of what is called 'journalism' in these days that any one who is gifted with a little facility in writing, a far-reaching imagination and a conscience without elastic limit may be properly 'assigned' to prepare an article on any subject whatever, and thus we are treated to weekly or monthly essays by one author covering, in fact sometimes rather more than covering, in a few months the whole area of human knowledge. Perhaps they, too, have their orders to produce a given number of 'sensations' in a given time.

Among many other evils growing out of what may be called 'Newspaper Science' not the least is the manufacturing and maintaining of false reputations. The constant appearance of a name in connection with the development of a given art, science, discovery or invention makes an impression which it is difficult to destroy, and this is true even among the most intelligent classes. To find who is really and truly eminent in any field of human activity one must go to the specialists in that field. The popular verdict is more than likely to be wrong because it is based on fictitious, newspaper-created renown. Is there not, indeed, some danger that in spite of the carefully selected and altogether able jury, the newly created roll of American honor may, in certain cases and for the lack of this appeal to specialists, become a Hall of Notoriety rather than Fame? The selection of S. F. B. Morse for a place therein must have been due to the general belief among the jurors that he was the inventor of the electro-magnetic telegraph. Yet it was long since proved beyond dispute that his share in that invention was among the least of the many who contributed to make the telegraph possible, and that he justly deserves only a relatively very small share of the honor belonging thereto.

T. C. M.

THE DATE OF PUBLICATION OF BREWSTER'S AMERICAN EDITION OF THE EDINBURGH ENCYCLOPÆDIA.

In commenting on a recent paper by Mr. J. A. G. Rehn (*Amer. Nat.*, XXIV., p. 575), Dr. J. A. Allen states (*Bull. Amer. Mus. Nat. Hist.*, XIII., p. 186) that the reference to "Brewster's American Edition, Edinburgh Encyclopædia, Vol. XII., Part II., p. 505, 1819," given by Mr. Rehn, "is erroneous as to date, and misleading as to the title of the work cited."

There is nothing whatever in Mr. Rehn's statement to warrant the idea that he had taken the reference at second hand, as Dr. Allen seems to have inferred, and as a matter of fact his reference is perfectly correct.

As Dr. Allen's positive statement that the work dates from 1832 is calculated to mislead others, it seems desirable to call attention to the facts in the case.

The earliest American edition of the work, entitled 'The American Edition of the New Edinburgh Encyclopædia,' was published at Philadelphia by Edw. Parker and Jos. Delaplaine, Edw. Parker, and Jos. Parker (the firm changing twice apparently), in 18 volumes, each in two parts, making 36 volumes in all. Each has the full title printed on the outside cover, together with the date of publication, which ranges from 1812 to 1831.

This edition was probably printed directly from the Edinburgh one, as fast as the parts came out. Of this, however, I am not sure, as I have not the dates of the latter at hand.

After this publication was finished, extra copies, which were apparently struck off from the same type, as they are absolutely identical, were bound up in 18 volumes with a new title page : 'The Edinburgh Encyclopædia conducted by David Brewster, first American edition,' all the volumes bearing date of 1832.

The statement 'first American edition' probably misled Dr. Allen, though except for the title page and introduction, this edition seems to be identical with the real first American edition of 1812–1831. Both 'editions' are in the library of the Academy of Natural Sciences of Philadelphia. WITMER STONE.

THE SPENCER-TOLLES FUND OF THE AMERICAN MICROSCOPICAL SOCIETY.

TO THE EDITOR OF SCIENCE: At the annual meeting of the American Microscopical Society, held in New York City during the last week in June, the especial attention of the Society was directed toward the Spencer-Tolles fund. As many are unfamiliar with the movement, permit us to state its history briefly as follows:

After the death of Charles A. Spencer in 1881 and of Robert B. Tolles a few years later, it was deemed fitting that a sum should be raised to provide a proper memorial to the father of American microscopy and his distinguished pupil, as a tribute due their services to the scientific world. The first notice of the movement was sufficient to bring, unsolicited, from the Royal Microscopical Society of London a contribution for this purpose. Additional sums subscribed by the members and others, together with the natural increase under the careful management of the Custodian, have brought the sum to a total at date of $756. The recent death of Herbert R. Spencer, the last of the three famous American workers, to whose efforts toward the perfecting of microscopic objectives the entire scientific world is so deeply indebted, serves as the immediate impulse of this movement toward the enlargement of the fund to a point at which its income may be sufficient to encourage in some way the advancement of science. It is accordingly desired that this tribute to the Spencers, father and son, and to their co-worker, Mr. Tolles, should be increased at once to the sum of at least $1,200, in order that the income therefrom may be offered each year under proper conditions as a reward for or assistance toward some scientific work or investigation of suitable character.

To this end the undersigned were appointed by the Society to secure cooperation in the effort to increase the fund, and to solicit contributions toward that end. We believe that the object will appeal to every one who is called upon to use the microscope in any capacity whatever, and contributions will be welcomed from all. Remittance should be made to Mr. Magnus Pflaum, Custodian of the Spencer-Tolles Fund, Bakewell Law Building, Pittsburg, Pa., who will at once return a proper receipt for the same.

For the American Microscopical Society.

Committee:

HENRY B. WARD, The University of Nebraska, Lincoln.

ADOLPH FEIEL, 520 East Main St., Columbus, Ohio.

HENRY R. HOWLAND, 217 Sumner St., Buffalo, N. Y.

Custodian:

MAGNUS PFLAUM, Bakewell Law Building, Pittsburg, Pa.

SOCIETIES AND ACADEMIES.

TORREY BOTANICAL CLUB, OCTOBER 9, 1900.

THE scientific program consisted of reports of summer work.

Mr. Harper reported collections in Georgia during three and a half months, traversing all the geological formations from the mountains to the sea, and collecting 754 numbers.

Dr. Rydberg reported two months spent in southern Colorado, with several new species; among them an interesting cactus from elevation of 8,000 feet in the Bitter Root mountains, now growing at the Botanic Gardens.

Dr. Howe reported nine weeks spent in collecting marine algæ at three very different stations, Bermuda, Martha's Vineyard (at Edgartown), and at Seguin Island, near the mouth of the Kennebec, an island four miles from the mainland, of about 150° elevation, its only inhabitants the three lightkeepers and families. Dr. Howe discussed the Bermuda flora in the light of the *Challenger* report, which recognizes 326 species, of which 144 are indigenous (in 109 genera and 50 families); out of the 144, 109 occur in the southeastern United States and 108 in the West Indies. The Bermuda vegetation is essentially West Indian in character, and includes only eight endemic species. Among the few found also at New York are *Osmunda regalis* and *cinnamomea*, *Woodwardia Virginica*, *Solidago sempervirens* and *Typha augustifolia*. Practically the only trees are the Palmetto and the Bermudian Cedar, the latter 20 to 50 feet high, and only one or two feet thick, though some old shells are five feet. The oleander is naturalized and in some quarters covered the whole landscape with bloom. Because of the practical absence of frost, tropical trees are acclimated with surprising success. The coffee tree has run wild in the sink-holes. About 25 ferns were known and eight Musci and six Hepaticæ had been already observed. There is nowhere any brook, and only one moss and one hepatica are common; the others are in the Devonshire marsh and the sink-holes of the Walsingham region. These are open caves 30 or 40 feet deep, with more moisture and shade and less wind, and therefore showing quite a different flora. There Dr. Howe discovered as many as 15 Hepaticæ. He also greatly increased the number of the marine algæ beyond the 132 of the *Challenger* report. The marine flora seems at first scanty on account of the absence of *Fucus* and *Ascophyllum*, but proves to be varied and interesting. It is practically that of southern Florida and the West Indies.

Dr. MacDougal reported work in northern Idaho in the Priest River basin which had perhaps never been visited by a botanist before. There was frost nearly every night. The tangled wildwood could not be penetrated more than four miles a day, except as it is entered by meadows stretching back from the lake. Beaver-dams a quarter mile long cross these meadows and convert the upper portions into sedgy marshes. A colony of beavers was active within 400 yards of his camp. Great stretches of *Drosera* carpet the marshes. Interesting plants were collected to 325 numbers.

Mrs. Britton sent in a brief report of her discovery of the protonema of Schizaea, observed as a green mat of thread-like bodies on the ground. On bringing them to the Botanic Gardens and cultivating them, she proved their development into Schizaea, and found the branching protonema to bear 2 to 15 flask-like archegonia on basal parts and a number of globose antheridia toward the apex. Description will follow in the November *Bulletin*. Dr. MacDougal remarked upon his observation of a mycorhizal association of a fungus in enlarged cells of this protonema. A similar association has been seen in the prothallus of Botrychium.

Professor Lloyd reported upon work on the Gulf coast begun after the close of his classes at the Columbia University summer school. Professor Lloyd and Professor Tracy procured a barge at Biloxi, Miss., by which they explored the flora of the islands of the Mississippi Sound and of the delta proper. It was necessary to sail for miles in two feet of water, occasionally jumping out to push. Always a furrow of mud followed in their wake. The islands bear a pine-barren and a sand-dune flora, with masses of *Pinguicula* and *Drosera*. The island surfaces are flat and form remnants of the tertiary Mississippi delta; they average only two feet above water, with a ridge a foot higher on the seaward side, composed of shell-fragments and continually shifted inward by the wind, the waves meanwhile gnawing off the seaward edge at the same rate.

Professor Burgess reported his continued observations on certain asters at stations near Lake Erie, Boston, the White Mountains, New York City, etc., at each of which he has kept certain varying species under scrutiny for some years, to determine their range of variation in nature under unchanged environment.

Professor Underwood reported herbarium work at Kew, the British Museum, and Paris, with particular reference to the herbarium of Cosson which is very rich in ferns, especially of South America and the West Indies. An interesting week was given to a trip to Biarritz, Spain, and the Landes, with views of the turpentine industry now flourishing among pine forests of the Landes originally planted as a protection from the sand-dunes. These pines average about ten inches in diameter. Maize was seen cultivated in the Basque provinces and to Bordeaux, the tops being cut off to favor the ripening of the ears, as in our South.

EDWARD S. BURGESS,
Secretary.

NOTES ON OCEANOGRAPHY.

THE DEEPEST FIORD ON THE LABRADOR COAST.

AN expedition on the schooner *Brave* spent the past summer exploring the northeastern coast of Labrador. Twenty-one soundings in Nachvak Bay sufficed to show that it is a typical fiord. The line of dangerous reefs two miles to seaward from the mouth of the bay belongs to a rock-sill which bars off the inlet from the deeper water of the Atlantic. Already at the mouth the depth is 107 fathoms. Six miles to westward, in the axis of the bay, the depth is 110 fathoms; for the next six miles it averages 100 fathoms. Then the bottom rapidly shoals to a narrow bar covered by no more than 18 fathoms. On account of its continuity with a projecting spur of bed rock on each side, it was concluded that the bar is composed of the same material. From the summit of this submerged ridge a second steep slope leads to a depth of 80 fathoms which persists to a point opposite the Hudson Bay Company's Post. Twenty miles from the mouth, a second bar of similar composition gave only 15 fathoms; it is flanked by depths of 60 fathoms. The bay has two branches, each heading about 25 miles from the bay-mouth, and is from one to two miles wide. Precipitous cliffs from 2,000 to 3,400 feet high appear in the profile of the U-shaped cross-section which is the rule in all parts of the bay. The deepest sounding recorded on the Admiralty charts for the bays of this coast is 100 fathoms in Hamilton Inlet.

The temperatures on August 30th were: at 110 fathoms, $-1°.7$ C. (29° F.); at 50 fathoms, $-1°.4$ C. (29°.4 F.); at 20 fathoms $-1°.2$ C. (29°.9 F.); at the surface, $+6°.8$ C. (44°.3 F.). The temperature of the water from 20 fathoms downward to 50 fathoms is colder than the water at corresponding depths in the open Atlantic outside. The bottom temperature is very close to that characteristic of the envelope of brackish water formed about a piece of sea-ice melting in normal open-Atlantic water. Drift-ice finally left Nachvak Bay this year as late as the first week in July.

DRIFT-ICE AND THE THEORY OF OCEAN CURRENTS.

THE extraordinary smoothness of the sea covered by drift-ice, even when the pans are widely spaced, is truly astonishing to one making his first voyage in such waters. His sailing ship may be favored with a fresh breeze and yet the ocean surface be quite level, save for the minute rippling characteristic of a small pond ruffled by a summer breeze; ground-swell does not exist. It is a matter of common knowledge among the fishermen of the Atlantic Labrador coast that the Labrador current, or 'tide,' as they invariably express it, often shows high velocity, although its surface, for a length of a thousand miles and a breadth of from one hundred to three hundred miles, is covered with loose pan-ice. At such times, the wind is, or has just been, strong and from a northerly quarter. We are justified in believing that the pans act as the sails which, in ice-free waters are represented by wind-waves. Floes and pans project above the surface from one to twenty feet or more. They may be expected to exert a coercive force on the film of relatively fresh water derived from the melting of the ice in contact with the heavier salt water beneath. According with the behavior of such 'dead water,' as described by Nansen and others, the light surface layer will tend to move *en masse* and in the direction of common pull exercised by the wind-driven masses of ice. By reason of friction the motion will be communicated to lower layers of the sea. This cause of surface currents is of importance to the theory of movement of those polar waters which, for several months after the winter ice begins to break up, are free from larger wind-waves. Deprived of its chief sails, the Labrador current, always sensitive to wind conditions and at times subject to temporary reversal with contrary winds, yet preserves and perhaps exceeds, during the period of ice-drift, the average velocity of current-flow for the year.

NOMENCLATURE OF TERMS USED IN ICE NAVIGATION.

A USEFUL 'list of some of the terms used in ice navigation by whalers, sealers and others' has been prepared by Commander William Wakeham, of the Canadian Marine and Fisheries (Report of the Expedition to Hudson Bay and Cumberland Gulf in the steamship *Diana*, 1897, Ottawa, 1898). Among the terms, the following are here noted with their definitions as expressed by Commander Wakeham :

Floe—A large mass of floating ice.

Pan—A small floe or small piece ; one that can be forced aside or slewed.

A field—A large body of ice that may be seen aronnd.

Land floe—Ice frozen ast to the shore.

Collar ice—Is the margin of ice frozen fast to an island or shore, presenting an abrnpt wall against which the floating ice rises and falls with the tide.

Growler—Is a more or less washed and rounded lnmp of ice which rolls about in the water, formed from broken up bergs or detached pieces of heavy old Arctic floe ice. [So called from the sound of heavy churning as the swell breaks at the undercut portion of the pan.]

Packed ice—Are small pieces closed together and held by the pressure of ice and currents.

Batture—Rafted ice [described on page 12 of the report].

Pressure ridge—Is the ridge or wall thrown np while the ice has rafted.

Slack ice—Is detached, so that it may be worked through. Ice is said to be slacking when it begins to be open so as to be navigable.

Running abroad—Ice is said to be running abroad when it opens out or slacks away so as to be navigable.

A nip—Ice is said to be uipping when it begins to close by reason of the action of winds or currents, so as to prevent the passage of a vessel.

Calving—Ice is calving when the small pieces break off from the bottom and rise to the surface of the water.

Slob—Is snow afloat and forming into ice.

Sish—Is thin young new ice, just formed in thin sheets.

Lolly—Is loose new ice.

Porridge ice—Is small, finely ground up ice.

Rafting—Occurs when two pans meet by force either by the action of wind or currents ; the edges are broken off and either rise on top of or pass under the body of the pans.

A lead—Is a strip of navigable water opening into the pack.

Slatches—Are considerable pools of open water in the ice.

Swatch—Is a small pool of open water in the ice.

Wash—Is the sound of the sea breaking against ice.

Rote—Newfoundland term for wash.

Water sky—Is a dark or bluish appearance of the sky indicating open water beyond the pack.

REGINALD A. DALY.
HARVARD UNIVERSITY.

AMERICAN ELECTRICIANS IN LONDON.

THE Central London Railway, the 'Electric Underground,' of London, the 'two-penny tube,' is one of the most important and, in some respects, far the most remarkable example of the work of the American electrician and engineer in Europe, perhaps in the world. It is a subterranean road running from Shepard's Bush, at the west, to the Bank in the city. It was opened last June by the Prince of Wales. Its 5¾ miles of route have seen the expenditure of about $15,500,000 during the four years of construction, and many minor bits of work remain to be performed. The original engineer of the work was the late Mr. T. H. Greathead. It was found necessary to come to the United States to secure its exceptionally large and powerful machinery and motive power. It is, in fact, an American electric railway in operation in London, the center of the brains and business of Great Britain. In one respect at least, however, it is novel as to its roadbed :

it is an 'undulating railway,' its stations are all set on the crest of gradients rising from either side, illustrating the plan proposed in Robert Stephenson's day by Badnall with the published approval of that great engineer.* This arrangement is perfectly feasible whereas here, the stops are all made at precisely the same points and with practically similar intermediate speed of trains. It insures gain in operation by the utilization of the stored energy of the train at a stop, instead of its waste by the use of the brake. Leaving the station, the descent is utilized in securing the required acceleration, thus again saving power. The gradients are 1.66 to 2.33 per cent., and the latter is equivalent to 74 pounds per ton on the draw-bar. One hundred horse-power minutes are thus gained at each stop and at each start.

The electric locomotives were supplied by the General Electric Co., the converters by the Thompson-Houston Co., the electric 'lifts' at the stations, dropping the passenger 60 to 90 feet at the start and raising him to the surface at his destination, were furnished by the Sprague Electric Co. The tunnel is double-barreled, each tube being 11 feet 6 inches in diameter. There are 13 stations and the running speed ranges from 14 to a maximum of 25 miles an hour between stations. Twenty-eight locomotives are employed; each hauling a train of seven carriages, conveying at most 336 passengers, the train weighing, empty, 105 tons, exclusive of the locomotive. The latter weighs about 50 short tons. Power is supplied also by an American firm, the E. P. Allis Co., who furnish six cross-compound engines, designed by Reynolds, of 1,300 to 1,900 horse-power each, and these are supplied with steam by 16 Babcock & Wilcox water-tube boilers—another American invention. The generators are three-phase, alternating current, with revolving fields. The armatures weigh 48,000 pounds. The output is 850 kilowatts, each, at 5,000 volts, 25 periods per second. Four six-pole exciters, driven, each, by a compound engine at 450 r. p. m., direct, supply to each generator 50 kilowatts at 125 volts. The switchboard is of marble. There are 19 miles of cable, weighing 78.4 tons. The engineers of the line are Messrs. Benjamin Baker and Basil Mott.

R. H. Thurston.

* Treatise on 'Railway Improvements,' by R. Badnall; London, Sherwood, Gilbert and Piper, 1833.

WIRELESS TELEGRAPHY.

Professor J. A. Fleming writes to the London *Times* the following letter on recent advances in wireless telegraphy:

As the subject of wireless telegraphy has not yet apparently lost interest for the general reader, I venture to ask a little space to make known for the first time some recent achievements by Mr. Marconi which have astonished those who have been allowed to examine them. Every one is aware that in his system of electric wave telegraphy an important feature is the employment of an elevated conductor, which generally takes the form of a wire suspended from a mast. When Mr. Marconi attracted attention by his feat of establishing communication across the Channel without wires, critics raised a not altogether valid argument against its commercial utility, that a wave or signal sent out from one transmitter would affect equally all receivers within its sphere of influence and hence the privacy of the communication would be destroyed. No one felt the force of this objection more strongly than the distinguished inventor himself, whose original work has caused so many others to attempt to follow in his steps. For the last two years he has not ceased to grapple with the problem of isolating the lines of communication, and success has now rewarded his skill and industry. Technical details must be left to be described by him later on, but meanwhile I may say that he has modified his receiving and transmitting appliances so that they will only respond to each other when properly tuned to sympathy. I am well aware that other inventors have claimed to be able to do the same thing, but I do not fear refutation in saying that no one has given practical proof of possessing a solution of this problem which for a moment can compare with that Mr. Marconi is now in a position to furnish.

These experiments have been conducted between two stations 30 miles apart, one near Poole in Dorset and the other near St. Catharine's in the Isle of Wight. At the present moment there are established at these places Mr. Marconi's latest appliances, so adjusted that each receiver at one station responds only to its corresponding transmitter at the other. During a three days' visit to Poole, Mr. Marconi invited me to apply any test I pleased to satisfy myself of the complete independence of the circuits, and the following are two out of many such tests: Two operators at St. Catharine's were instructed to send simultaneously two different wireless messages to Poole, and without delay or mistake the two were correctly recorded and printed down at the same time in Morse signals on the tapes of the two corresponding receivers at Poole.

In this first demonstration each receiver was connected to its own independent aërial wire hung from the same mast. But greater wonders followed. Mr. Marconi placed the receivers at Poole one on the top of the other, and connected them both to one and the same wire about 40 ft. in length, attached to a mast. I then asked to have two messages sent at the same moment by the operators at St. Catherine's, one in English and one in French. Without failure each receiver at Poole rolled out its paper tape, the message in English perfect on one and that in French on the other. When it is realized that these visible dots and dashes are the results of trains of intermingled electric waves rushing with the speed of light across the intervening 30 miles, caught on one and the same short aërial wire and disentangled and sorted out automatically by the two machines into intelligible messages in different languages, the wonder of it all cannot but strike the mind.

Your space is too valuable to be encroached upon by further details, or else I might mention some marvellous results, exhibited by Mr. Marconi during the same demonstrations, of messages received from a transmitter 30 miles away and recorded by an instrument in a closed room merely by the aid of a zinc cylinder, four feet high, placed on a chair. More surprising is it to learn that, whilst these experiments have been proceeding between Poole and St. Catherine's, others have been taking place for the Admiralty between Portsmouth and Portland, these lines of communication intersecting each other; yet so perfect is the independence that nothing done on one circuit now affects the other, unless desired. A corollary of these latest improvements is that the necessity for very high masts is abolished. Mr. Marconi now has established perfect independent wireless telegraphic communication between Poole and St. Catherine's, a distance of 30 miles, by means of a pair of metal cylinders elevated 25 or 30 feet above the ground at each place.

I need not enlarge on the possibilities thus opened out for naval and military purposes. The importance of this practical solution of the problem of independent electric wave telegraphy, in which each wireless circuit is as private as one with a wire, is obvious without comment. My desire is solely to mention the above facts for the benefit of general readers, whose minds will thus perhaps be eased of any doubts lest this brilliant application of electrical discoveries should, like some others, fall short of satisfying the requirements of practical use and be relegated to the region of imperfect inventions or unfulfilled hopes.

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*SPECIES OF MOSQUITOES COLLECTED FOR THE BRITISH MUSEUM.**

AT the latter end of 1898 a committee was appointed jointly by Mr. Chamberlain and the Royal Society to exercise a general supervision over a scientific investigation of malaria, and it was then suggested that, in view of the connection of malaria with mosquitoes, it would be desirable to obtain exact knowledge of the different species of mosquitoes and allied insects in the various tropical colonies. Acting on this suggestion, Mr. Chamberlain at once issued a circular despatch to the Governors of all the Crown colonies, requesting them to take the necessary steps to have such collections made and sent to the Natural History Museum for examination and classification of the specimens. For the guidance of those who might be employed on the work, directions for collecting, mounting and preserving the insects were drawn up by the museum and distributed in the colonies. As a result of these measures considerably over 3,000 specimens of mosquitoes have, we learn, been received at Cromwell-road up to

* From the London *Times*.

the present from various quarters, and collections are still coming in almost every week. The work of identifying and describing the specimens was at first entrusted to Mr. E. E. Austen, the dipterist on the staff of the museum, but later he volunteered for active service in South Africa and joined the City Imperial Volunteers. Apart from his duties as a soldier Mr. Austen has, we hear, done useful service in his capacity of naturalist in the South African Field Force. There are not many professional dipterists in this country, and it was therefore fortunate that the director of the museum, Professor Ray Lankester, was able to obtain the services of Mr. F. V. Theobald, a graduate of the University of Cambridge, who is one of the few men in England who has studied mosquitoes, to carry on the work in Mr. Austen's absence. Mr. Theobald is now engaged in the preparation of a monograph on mosquitoes, based on the collections at the museum, the printing of which has been sanctioned by the trustees.

Pending the issue of this catalogue, it has been thought desirable, for the satisfaction of those who have been at the trouble to make the collections, to print a preliminary report of the progress made by Mr. Theobald in identifying the specimens already received. The combined collections contain a large number of species, the majority belonging to the genus *Culex*. Mr. Theobald at present has completed the genus *Anopheles*, which has been hopelessly convicted of being the medium by which the malaria parasite is transmitted from person to person. The genus is represented in the museum by 22 species, 10 of which are new to science. The *Anopheles*, unlike the comparatively inocuous *Culex*, does not appear to have a wide distribution in regard to species, although the genus is world-wide. One of the greatest distances between any two localities for the same species is Formosa and the Straits Settlements. A long series sent by Mr. Wray from the Straits Settlements contained 66 *Anopheles* and 72 *Culex*, the former being remarkable for their great variation both in color and in size; whereas all the other specimens of the genus received appear very constant in color and markings. Some species of *Culex* seem to have a very wide distribution. Thus one species has been sent from the following widely-separated localities: Japan, Formosa, Hong-kong, Malay Peninsula, India, South and West Africa, North and South America, West Indies aud Gibralter. As many of the species are very obscure, photographs of the wings and drawings of various parts are being prepared, and complete figures of the majority of species will also be given in the proposed monograph. The collection and preservation of these tiny and very delicate insects are a most difficult matter, involving unwearied patience and extreme care. The fact that most of the collections have arrived at the museum from remote parts of the world in fair condition says much for the zeal and care with which the gentlemen concerned have endeavored to carry out the wishes of the Colonial Secretary in this important investigation.

YELLOW FEVER AND MOSQUITOES.

A preliminary paper on the etiology of yellow fever, by Walter Reed, surgeon, United States army, and James Carroll, A. Agramonte, Jesse W. Lazear, assistant surgeons, United States army, was read at the recent meeting of the American Public Health Association at Indianapolis and is published in the last issue of the *Philadelphia Medical Journal.* It appears that in eleven cases in which non-immune individuals were inoculated through the bites of mosquitoes (*culex fasciatus*) two attacks of yellow fever followed and that another attack is directly traced to the bite of a contaminated mosquito. The authors conclude as follows:

For ourselves, we have been profoundly impressed with the mode of infection and with the results that followed the bite of the mosquito in these three cases. Our results would appear to throw new light on Carter's observations in Mississippi, as to the period required between the introduction of the first (infecting) case and the occurrence of secondary cases of yellow fever.

Since we here, for the first time, record a case in which a typical attack of yellow fever has followed the bite of an infected mosquito, within the usual period of incubation of the disease, and in which other sources of infection can be exclnded, we feel confident that the publication of these observations must excite renewed interest in the mosquito-theory of the propagation of yellow fever, as first proposed by Finlay.

From the first part of our study of yellow fever, we draw the following conclusions:

1. The blood taken during life from the general venous circulation, on various days of the disease, in 18 cases of yellow fever, successively studied, has given negative results as regards the presence of *B. icteroides.*

2. Cultures taken from the blood and organs of 11 yellow fever cadavers have also proved negative as regards the presence of this bacillus.

3. *Bacillus icteroides* (*Sanarelli*) stands in no causative relation to yellow fever, but, when present, should be considered as a secondary invader in this disease.

From the second part of our study of yellow fever, we draw the following conclusions:

The mosquito serves as the intermediate host for the parasite of yellow fever, and it is highly probable that the disease is only propagated through the bite of this insect.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR S. P. LANGLEY, director of the Smithsonian Institution returned to the United States on October 24th. He was given the honorary degree of Doctor of Science on October 11th, by Cambridge University.

THE Rumford Committee of the American Academy of Arts and Sciences has voted a grant of $200 to Mr. C. E. Mendenhall of Williams College for the furtherance of his investigations on a hollow bolometer, and a grant of $500 to Professor George E. Hale of the Yerkes Observatory in furtherance of his researches in connection with the application of the radiometer and a study of the infra-red spectrum of the chromosphere.

DR. E. W. HOBSON, F.R.S., has been nominated for the presidency of the London Mathematical Society, succeeding Lord Kelvin.

SIR LOWTHIAN BELL, F.R.S., succeeds the Hon. C. A. Parsons, F.R.S. as president of the British Institution of Junior Engineers.

PROFESSOR BRUHNES, who holds the chair of physics in the University of Dijon, has been appointed director of the observatory on the Pui-de-Dôme.

MR. MARSHALL H. SAVILLE, of the American Museum of Natural History, left for Southern Mexico on November 1st, where he will continue his excavations in the territory formerly occupied by the Zapotecans.

DR. KARL E. GUTHE, of the department of physics of the University of Michigan, is spending the present year in Leipzic, Germany, conducting investigations in the general subject of physical chemistry.

A BRONZE medallion with a likeness of Sylvester will hereafter be awarded as a mathematical prize at the Johns Hopkins University.

THE death is announced, at the age of seventy-seven years, of Dr. Friedrich Max-Müller, Corpus professor of comparative philology at Oxford University, well-known throughout the world for his researches in oriental philosophy and literature and for his more popular writings, covering a wide field.

DR. MOSES C. WHITE, emeritus professor in the Yale Medical School, died on October 24th aged seventy-nine years, and Dr. Lawrence Turnbull, the author of numerous works on diseases of the eye and ear, and a well-known specialist, on October 24th, aged seventy-nine years.

WE regret also to record the death at the age of sixty-one years of Dr. A. B. Frank, professor of botany in the Agricultural School at Berlin and director of the biological division of the Imperial Board of Health; of Dr. Robert Hegler, docent in chemistry in the University at Rostock, on September 29th, aged thirty-one years, and of Dr. Ferdinand Anton, director of the astronomical and meteorological observatory of Trieste, on October 3d, at the age of fifty-six years.

WE have already called attention to the appointment of a Baird Memorial Committee, of which Dr. H. M. Smith is chairman, the object of which is to erect a tablet or monument at Woods Holl in memory of the late Spencer F. Baird. The nature of the proposed memorial has not yet been determined as it must depend on the amount subscribed, but the committee are now prepared to receive subscriptions. Any contribution will be acceptable, but the committee are especially anxious to receive a large number of small individual subscriptions. These may be sent to the treasurer of the committee, the Hon. E. G. Blackford, Fulton Market, New York City.

The Eighteenth Congress of the American Ornithologists' Union will convene in Cambridge, Mass., on Monday, November 12th at 8 o'clock P. M. The evening session will be devoted to the election of officers and the transaction of other routine business. The meetings, open to the public and devoted to the reading and discussion of scientific papers, will be held in the Nash Lecture room, University Museum, Oxford St., beginning Tuesday, November 13th, at 10 A. M., and continuing for three days.

The Trustees of the Carnegie Institute, Pittsburg, have sent invitations for the celebration of Founders Day in Music Hall and for an exhibition of the Art Gallery, Library and Museum on Thursday afternoon, November 1st. The Museum has been greatly enriched during the present year by the fossil vertebrates of Wyoming and South Dakota, which will be described by Dr. J. B. Hatcher in the next issue of this Journal.

The lecture arrangements of the London Institution for the present season include the folowing: 'The Rise of Egyptian Civilization,' by Professor Flinders Petrie; 'The Earth's Beginning,' by Sir Robert Ball; 'The Earth's Earliest Inhabitants,' by Professor Grenville Cole; 'The Caves of Jenolan,' by Mr. F. Lambert; 'The Tercentenary of the Science of Electricity,' by Professor Sylvanus Thompson; 'The Evolution of the Brain,' by Dr. Alex Hill; 'Modern Aeronautics,' by Mr. Eric S. Bruce; 'The First Ascent of Mount Kenya,' by Mr. H. J. MacKinder; 'The Effect of Alcohol on the Nervous System,' by Professor Victor Horsley; 'The Decorative Art of Primitive Peoples,' by Professor A. C. Haddon, and 'Aquatic Autocrats and Fairies,' by Mr. F. Enock.

A civil service examination will be held on November 20th to fill the position of assistant biologist in the Division of Biological Survey, Department of Agriculture, at an annual salary of $1,500. The subjects and their weights are as follows: Essay writing, 1; French, 1; German, 1; physical geography of the United States, 1; ornithology and mammalogy, 3; identification of specimens, 3.

According to the St. Petersburg *Gazette*, the Russian Government has decided to adopt the metric standard of weights and measures, and the ministry of finance is now engaged in considering the time and manner of introducing this reform.

The expedition sent by the Harvard Observatory to observe the planet Eros in its approaching opposition has arrived at Kingston, Jamaica, and is being afforded facilities for its work by the Government.

A cable dispatch to the New York *Sun* states that an official report of the Duke of the Abruzzi's discoveries in the north is published in the *Rivista Maritima.* It says the expedition corrected the position of Cape Flora, and reports that King Oscar Island and Petermann Land do not exist.

A pathological institute is being built at Quala Lumpoy, the capital of the federated Malay States, and Dr. Hamilton Wright has been appointed director. The British Colonial Office has offered to pay the expenses of students who wish to study beri-beri and malaria at the new institute.

Vice-Consul General Hanauer, of Frankfort, under date of September 29, 1900, says: Molten wood is a new invention by Mr. De Gall, inspector of forests at Lemur, France. By means of dry distillation and high pressure, the escape of developing gases is prevented, thereby reducing the wood to a molten condition. After cooling off, the mass assumes the character of coal, yet without showing a trace of the organic structure of that mineral. This new body is hard, but can be shaped and polished at will; is impervious to water and acids, and is a perfect electrical non-conductor.

The London *Times* states, that a meeting of the British and American members of the International Association for the Advancement of Science, Arts and Education was held in the

United States pavilion at the exhibition on September 14th. Mr. Bryce, M.P., vice-president of the British group, was in the chair. The officials and various members of the French, Russian, and German groups of the Association were also present. A report prepared by the secretaries of the work of the first year was read by Professor Patrick Geddes. He described the work in Paris, which has been to provide, on the one hand, a rendezvous and center for scientific men and others attending the congresses of the exhibition; and, on the other, to provide for the public interested in various sections expert guidance to these. He further stated that a series of brief reports were being prepared by members of the assembly on special phases of the exhibition, and that it was proposed to organize assemblies at the Glasgow Exhibition of 1901 and the St. Louis Exhibition of 1903. Resolutions commending the work of the Association in all its branches and approving the proposals for future activities were proposed and carried unanimously. The chairman, in supporting the resolutions, said that he hoped all present would endeavor to bring the aims of the organization to the knowledge of those who would be able to give it financial help. He wished to dwell for a moment on the excellent evidence of international cooperation which was to be seen in this Association. Lately there had been a meeting of Chambers of Commerce in Paris, and much had been said of the advantages to be gained from peace and harmony among the nations. But commerce, much as they desired it to be means of peace, sometimes led to strife. He thought there was something which made far more strongly for peace, and that was science and learning, which did not depend for their growth on competition and rivalry. For this reason he felt that their association should be a great factor towards international understanding. He felt the exhibition had made an opportunity for the coming together of the *savants* of the world, and the International Association gave the means to continue the friendly relations there begun.

A REPORT on the plague in Egypt, covering the period from May, 1899, to July, 1900, which has been issued from the Sanitary Department of the Ministry of the Interior at Cairo, according to the London *Times*, contains a very full and clear account of the outbreak at Alexandria which commenced in the first named month, and the last case of which occurred on the 5th of the following November. In all 96 cases became known to the authorities; and it was estimated that 27 more, of mild character and followed by recovery, might possibly have escaped notification. The 96 were made up of 66 natives and 30 foreigners, the latter mostly Greeks, Frenchmen or Italians employed in groceries, bakeries, wine shops or at restaurateurs. The mortality among reported cases was 48 per cent., and there was reason to believe that no death from plague escaped notice. The precautions taken for arresting the course of the disease appear to have been admirably devised and conducted, and are set forth under the three heads of—(1) measures to assure prompt discovery of each case of plague and of all suspicious cases; (2) direct measures to prevent the propagation of the disease from individual cases; and (3) indirect measures, such as general cleansing of dirty quarters, with a view to eliminate all conditions favorable to the existence or propagation of the disease. A sum of £E.30,000 was granted by the Caisse de la Dette to defray the extra expenses, and was placed at the disposal of the Director-General of the Sanitary Department; but the total outlay exceeded this sum by £E.4000; and the whole of the work required seems to have been carried out with great discretion and tact, and with the *minimum* of offence to religious or other susceptibilities. The description of the administration, which is in English, is followed by a report in French on the clinical histories of the more important cases, a history from which it appears that, without bacteriological examination, the diagnosis of plague is beset by great difficulties and must often be extremely uncertain.

UNIVERSITY AND EDUCATIONAL NEWS.

THE daily papers report that a trustee of Beloit College has offered to contribute $200,000 in case the further sum of $150,000 is collected for the College.

MR. HOLBROOK GASKELL has given $5,000

towards a new physical laboratory for University College, Liverpool. It appears from the report of the treasurer of the College that there was last year a deficit of $6,000 and that the debt of the College is $55,000.

The Oxford City Council has secured a new valuation of the property of the University and the Colleges which would subject them to an increased tax of $23,000 a year. The question of increased valuation will probably come before the Courts.

According to the daily papers Lafayette College conferred on October 24th, an honorary Ph.D. degree on the Rev. Ernest P. F. Pfattecher of Lebanon. If this news is correct the Association of Colleges and Preparatory Schools of the Middle States and Maryland should at its approaching meeting take action that will prevent the improper use of this degree.

The registration at Harvard University is as follows: in the college, senior class, 391; junior class, 379; sophomore, 539; freshman, 537; special students, 149; total in college, 1,995, a gain of 99 over last year; the scientific school, 506, a gain of 12; graduate school, 327, a gain of 12; divinity school, 25, a loss of 2; law school, 618, a gain of 14; medical school, 590, a gain of 40; dental school, 129, a loss of 3; veterinary school, 17, a loss of 7; Bussey institution, 27, a gain of 2; total for the academic year 1900, 4,234; total gain, 167.

The enrollment of undergraduates at Princeton University shows a total gain of 120 compared with the figures of last year. There are 745 academic students, an increase of fifty-nine, and 421 in the scientific department, a gain of fifty-eight. Seven men are registered in the electrical school, against four last year.

At Williams College Dr. F. H. Howard, of the College of Physicians and Surgeons of New York, has been appointed instructor in physiology and hygiene in place of Dr. Woodbridge, who died a year ago.

The income of the Stearns' Fellowship in the pharmaceutical department of the University of Michigan for the present and sixth year has been divided between Harold C. Watkins and Charles R. Eckler, who are at work in parallel lines upon the same subject, namely, the chemical and botanical characteristics of certain plants of the poppy family. Mr. Watkins will investigate the chemistry, Mr. Eckler the botanical characteristics of the plants. The work is under the supervision of Professor Julius O. Schlotterbeck.

Sir H. E. Roscoe, F.R.S., is vice-chancellor of the reorganized University of London, and Sir John Wolfe Wolfe-Barry, F.R.S., is one of the crown members of the senate. The faculty members representing science are Sir Michael Foster, Sec. F.R.S., Dr. William B. Halliburton, F.R.S., Professor William Ramsay, F.R.S., and Professor A. W. Rücker, F.R.S. The representatives of the different institutions in the senate also include a number of scientific men —Lord Lister, Professor G. C. Foster, Dr. P. H. Pye-Smith and others.

Professor T. G. Bonney, F.R.S., has resigned from the chair of geology in University College, London, which he has held for thirty-three years.

The Committee of the School of Geography, at Oxford University, has elected the Rev. Edward Clarke Spicer, of New College, to the Geographical Scholarship for 1900–1901.

Dr. Hans Georges, engineer-in-chief of the firm of Siemens & Halske, has been appointed director of the Electrical Engineering Institute and professor of electrical engineering in the Dresden Institute of Technology.

Dr. Lorenz, of the University at Halle, has been made director of the Physical and Technological Institute of the University at Göttingen.

Dr. M. von Raciborski has been appointed professor of botany and director of the botanical gardens in the agricultural school at Dublaney, near Lemberg.

Dr. Franz Kolacek, of the Bohemian University at Prague, has been appointed professor of physics in the School of Technology at Brünn, and Dr. Sauer of Heidelberg professor of mineralogy and geology in the Polytechnic Institute at Stuttgart. Dr. Emil Borras of the Geodetic Institute at Pottsdam has been promoted to a professorship.

SCIENCE

Friday, November 9, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE IMPERIAL PHYSICO-TECHNICAL INSTITUTION IN CHARLOTTENBURG.**

I. HISTORICAL.

Through the courtesy of Professor Kohlrausch, President of the Reichsanstalt, and the Curatorium or governing body of the institution, the writer was accorded the privilege of working in the Physikalisch-Technische Reichsanstalt as a scientific guest during the last few months of 1899. An unusual opportunity was thus afforded of learning rather intimately the methods employed and the results accomplished in this famous institution for the conduct of physical research, the supply of standards and the verification of instruments of precision for scientific and technical purposes.

It is well-known that the Reichsanstalt is situated in Charlottenburg, a suburb of Berlin just beyond the renowned Thiergarten. The buildings occupy an entire square, the larger part of which, valued at 500,000 Marks, was the gift of Dr. Werner Siemens. In making this gift, which was offered in land or money at the option of the government, Dr. Siemens declared that he had in mind only the object of serving his fatherland and of demonstrating his love for science, to which he avowed himself entirely indebted for his rise in life.

* A paper presented at the 146th meeting of the American Institute of Electrical Engineers, New York, September 26, 1900.

The gift was made as a stimulus to the government to establish an institution for physical research. The kind of institution desired had been amply described in suitable memorials prepared by himself, Professor von Helmholtz and others of scarcely less distinction. The first memorial bears the date of June 16, 1883. It relates to 'The Founding of an Institution for the Experimental Promotion of Exact Natural Philosophy and the Technical Arts of Precision.' It points out the need of such an institution, details the benefit likely to accrue from it, lays great stress on the intimate relation existing between scientific investigations and their application in the useful arts, and sets forth somewhat in detail a plan of organization. The memorialists had in mind at that time a 'Physico-Mechanical Institution,' but in the memorial of the following year (March 20, 1884) the title was changed to the one which the institution now bears—'Physikalisch-Technische Reichsanstalt.' From this second memorial it is learned that the first steps toward the furtherance of exact science and technical precision, in an institution to be founded and maintained by the State, were taken as early as 1872. This movement had the support of the crown-prince, the late Emperor Frederick, and the matter was taken in hand by Count von Moltke as chairman of the Central Bureau for Metrology in Prussia. He called together a commission near the end of the year 1873, and in the following January this commission reported a series of propositions for the improvement of the scientific, mechanic arts, and of instruments of precision. These propositions formed the foundation for a memorial on the same subject to the Chamber of Delegates of the Prussian Government in 1876. The result was that appropriate rooms were set aside in the new building of the Technical High School in Charlottenburg for the organization of an institution for the cultivation of the arts of precision.

The general plan of the Reichsanstalt was adopted in 1887, and an appropriation of 868,254 Marks was made and spread over the budget for three years. The main building for the first or scientific division was completed in 1893. The second or technical division was housed in a portion of the Technical High School till the buildings for this division were completed in 1897. All departments of activity of the Reichsanstalt are now accommodated on the square facing on March Strasse in Charlottenburg. They include the division for pure scientific research, mechanical measurements of precision, electrical measurements and instruments, the measurement of large direct and alternating currents and electromotive forces, the optical department, the department of thermometry, the department of pyrometry and the department of chemistry. To these as auxiliaries should be added the power plant and the workshop.

II. ORGANIZATION.

The two divisions into which the Reichsanstalt is divided correspond to the two paramount objects which the founders had in view, viz., research in pure science, and the cultivation of precision in the technical applications of science. The same idea is embodied in the very name of the institution—the Imperial Physico-Technical Institution. If the sole purpose of the Anstalt had been the promotion of improvement in the mechanic arts, in engineering and in instruments of precision, the first or scientific division would still have been essential to secure the ends sought. All the applications of science rest on the foundation of pure scientific discovery. The creation of new and improved methods and instruments for physical measurements requires the most exhaustive and painstaking investigations as a preliminary to a steady and confident advance. The practical value of research in pure science is no longer in question. The wise founders of the Reichsanstalt made no mistake in coupling an institution for the promotion of technical precision with one for the prosecution of research in physical science.

The governing body or Curatorium of the Reichsanstalt is appointed by the Emperor. At its head is Herr Weymann, Imperial Privy Counsellor. The function of the Curatorium is the appointment of the officials and the general management of the institution. The chief officer of the Reichsanstalt is the President, and the most distinguished physicist of the realm is sought for this position. Helmholtz was taken from the University in Berlin to become the first incumbent of the office; after his death in 1893, his successor as professor of physics in the University, Professor F. Kohlrausch, became his successor as President of the Reichsanstalt.

The President, who is at the same time director of the first division, is held responsible for the successful work of the Reichsanstalt. All other officials are therefore subordinate to him. In his absence the duties of his office devolve upon the Director of the technical division. Subordinate to the director of this second division are the professors, associates, and assistants of various grades. A professor in charge of a department has the direction of all those employed in it, including a skilled departmental mechanician.

The specific duties of the President may be briefly enumerated. He must lay before the Curatorium at its annual meeting the following:

1. A report on the work executed in both divisions.

2. The plan of work for the undertakings to be carried out the ensuing year.

3. Propositions relative to the money to be expended for scientific and technical work; also for salaries and remunerations.

4. Propositions relative to the rank of permanent associates and assistants; also relative to the bestowal of places to work in the Reichsanstalt as scientific guests.

He takes a vote on the propositions in 3 and 4, and reports the conclusions of the Curatorium to the government for approval. It is also the duty of the President to sign vouchers for all payments, and he is held responsible for the proper expenditure of the money appropriated for the maintenance of the institution.

The different functions of the two divisions composing the institution are defined in rather broad terms. It is the duty of the first division to carry out physical investigations requiring more uninterrupted time on the part of the observer, and better accessories in the way of instruments and local appliances, than private individuals and laboratories of institutions for teaching as a rule can offer. These investigations shall be carried out partly by officers of the Anstalt and partly, under their oversight, by scientific guests and voluntary workers. By scientific guests in general are meant the holders of scientific positions in the German Empire who wish to prosecute scientific researches, the plan of which they have submitted, and for which they have not at home the necessary appliances. They must be recommended by the State in which they reside and must be accepted by the Curatorium.

Young men may be accepted as voluntary workers who have proved their ability by scientific publications. They will undertake researches which have been determined upon by the Curatorium or the Director; or they may investigate subjects which they themselves suggest, and which appear to the Director to be practicable and worthy of execution. The scientific results obtained must be published only at the discretion of the authorities of the institution, who reserve also the right to publish them in the researches of the Reichsanstalt. Provision is made that voluntary workers shall not use the institution for private ends nor to obtain patents.

The second division of the Reichsanstalt is placed under a Director, who is subject to the higher authority of the President. Such a Director was considered necessary on account of the special work of this division, as well as because of the intimate relations into which it is brought with many persons engaged in industrial pursuits. He should therefore not only be a scientific man, but should at the same time have some technical knowledge of the applications of science. Under the Director are placed the permanent heads of the subdivisions of the technical department, one having the oversight of thermometry, one of optics, two of electricity, and one of mechanical measurements of precision. Along with these, and of the same rank and compensation, is the director of the workshop. Under him at present are eight mechanics, and the shop is provided with the finest tools for the execution of the most exact work required by the institution. For example, it has a circular dividing engine that cost $2,500. The founders of the Reichsanstalt foresaw the necessity of such mechanical aids for the furtherance of the exact work to be undertaken. They wisely concluded that such special constructions and new types of instruments as they might require from time to time could be more conveniently and more cheaply built in their own shop than by private instrument makers.

III. COST AND MAINTENANCE.

The following are the official accounts of expenditures for the grounds, buildings, furniture and instruments for the two divisions, to which are added the yearly expenses:

DIVISION I.

1. Acquisition of ground, the gift of Dr. Werner Siemens	500,000 M.	
2. For erection of buildings:		
a. Main Building	387,000 "	
b. Machinery Building.	50,000 "	
c. Administra'n Building	100,000 "	
d. President's House	99,254 "	
e. Grading, Paving, etc.	10,472 "	
f. Paving Half of Street	30,274 "	
g. Building for Battery	8,500 "	
3. Fittings and Furniture	58,000 "	
4. Equipment of Machinery and Instruments	82,310 "	1,325,810 M.

DIVISION II.

1. Acquisition of Ground	373,106 M.	
2. Erection of Buildings:		
a. Main Building	922,000 "	
b. Laboratory Building	218,000 "	
c. Machinery Building.	180,000 "	
d. Dwelling for Offic'ls.	140,000 "	
e. Additional Improvements	348,000 "	
3. Fittings and Furniture	108,300 "	
4. Equipment of Machinery and Instruments	471,390 "	
	2,760,796 M.	
Less reduction for 1895–96	47,500 "	2,713,296 M.
Divisions I and II together.		4,039,106 M.

The annual expenditures for 1899 were as follows:

1. Expenditures for Salaries and Laborers	206,604 M.
2. Miscellaneous Articles, Experimental Work and Care of Buildings	127,000 "
Total	333,604 M.

The receipts for calibrating instruments, testing materials, verifying standards and the like now amount to about 40,000 M. annually. This sum should be deducted from the yearly expenditures, leaving a net sum of about 300,000 M.

In round numbers the Reichsanstalt has cost $1,000,000, and the annual appropriation for its maintenance is $75,000.

IV. RESULTS.

A very pertinent inquiry is, what are the results of all this expenditure? Might not more good be accomplished by State aid to some existing technical school or university? The results attained must be set by the side of the objects which the founders of the institution had in view in order to ascertain whether the sequel has justified their predictions. In the memorials to which reference has already been made, Professor von Helmholtz and Dr. Werner Siemens pointed out the advantages likely to accrue to Germany from the maintenance of an imperial institution for research, which should at the same time assume the cognate function of fixing and certifying standards of mechanical and physical measurements. Attention was drawn to the fact that other countries, notably England, had enjoyed great renown in science because of the brilliant researches and discoveries of some of her scientific men, who had the good fortune to be possessed of leisure and large private means, and the scientific spirit to devote them to investigations demanding both as a *sine qua non*.

These conditions the memorialists declared were lacking in the fatherland. Her scholars who had the enthusiasm and the capacity for exact scientific investigation possessed neither the private fortune to devote to it, nor the uninterrupted time for the execution of the work. They were to be found among the men engaged in teaching, but their professional duties absorbed their time to such an extent that only an inadequate residue remained; and even this little was divided into fractions too small to admit of the sustained and continuous attention which any important investigation demands.

It was further pointed out that if the government would supply the conditions favorable to scientific discovery, the men could be found whose work would reflect great credit on the State, while the interaction between pure science and its applications to arts and manufactures would put Germany in the forefront of scientific renown and of the intelligent application of science to useful purposes.

It was further urged by von Helmholtz that the brilliant investigations of Regnault and other French physicists many years ago should now be repeated with the superior methods and instrumental appliances available at the present time. These investigations drew the attention of the scientific world to France and made it the focus of scientific interest. Her instrument makers, even up to the present, have reaped a rich reward in foreign orders for instruments made eminently desirable and almost indispensable by these distinguished French investigators.

Other problems, too, needed solution, problems forced to the front by modern requirements and discoveries. The applications of electricity, for example, present new questions for science to answer, while the interests of the consumer at the same time call for some form of control by the State of the instruments employed in fulfilling contracts. The very units in which such measurements are made need to be authoritatively settled—a task demanding the highest manipulative skill in experiment and the most refined appliances which experience can suggest and money purchase.

The German government admitted the force of these considerations and made splendid provision, for both pure science and its technical applications, by founding the Imperial Institution at Charlottenburg. The results have already justified in a remarkable manner all the expenditure of labor and money. The renown in exact scientific measurements formerly possessed by France and England has now been largely transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity. Now they go to Germany. So completely has the work of the Reichsanstalt justified the expectations of its founders, and so substantial are the products of this already famous institution that other European nations are following Germany's example. Great Britain has already made an initial appropriation for a National Physical Laboratory to be organized on a plan similar to that of her Teutonic neighbor. Mr. R. T. Glazebrook, who has long served as secretary of the electrical standards committee of the British Association for the Advancement of Science, has been appointed Director and has entered on his duties. The new institution will absorb the old Kew Observatory, and other buildings will be added at once for the extension of the functions of this Observatory so as to include the larger enterprise contemplated in the establishment of the new National Laboratory.

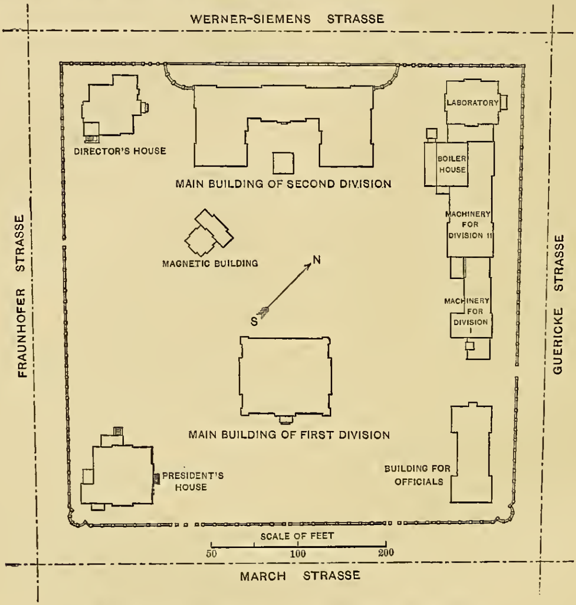

Fig. 1.—General Plan of Ground and Buildings.

Russia also has a number of large and well equipped laboratories in connection with her Central Bureau of Weights and Measures. One of these is devoted to the verification of instruments for electrical measurement. It employs fourteen men and the budget is about $45,000 per annum.

France is moving in the same direction. The great service of France in fixing standards of length and mass has long been freely recognized by the civilized world. But her national bureau for this purpose is now considered to be too limited in scope to solve the new problems presented. Quite recently a committee of learned men from Paris, under the leadership of Minister Bourgeoise, visited Charlottenburg for the purpose of examining into the working of the renowned institution located there. Professor Violle, one of the most illustrious physicists of the French capital, accompanied the committee. What better evidence of the success of Germany's great institution can be demanded than the consensus of favorable opinion among those best qualified to judge that its fruits are already of the highest order of merit, and its imitation by other European nations—the sincerest form of flattery.

It would not be just to form an estimate of the success of the Reichsanstalt without taking into account its scientific publications. These are numerous and of great value. Most of the reports of work done are made public with official sanction in various scientific and technical journals. During the past year thirty such papers have been published. The detailed accounts, however, of the most important undertakings thus far completed are contained in three quarto volumes of investigations. Among those contained in the first two volumes may be mentioned papers pertaining to thermometry and to units of electrical resistance.

The investigations in thermometry comprise such topics as the influence of the glass on the indications of the mercurial thermometer, division of the thermometer and determination of the errors of division, determination of the coefficient of outer and inner pressure, determination of the mean apparent coefficient of expansion of mercury between 0°C. and 100°C. in Jena glass, and investigations relating to the comparison of mercurial thermometers.

Four papers of exceptional value relate to normal standards of electrical resistance. They are, the probable value of the ohm according to measurements made up to the present time, the determination of the caliber correction for electrical resistance tubes, the normal mercury standard ohm and the normal wire standard ohm of the Reichsanstalt. When one recalls that the ohm as a practical unit of measurement is defined in terms of the resistance of a specified column or thread of mercury, it will readily be seen that the work done at Charlottenburg in this particular field is fundamental in character and of the most universal importance.

In passing it is worthy of remark that all the standard resistances designed and constructed at the Reichsanstalt are carefully compared with the mercurial standards early in each year. This custom is in accordance with the action taken by the electrical standards committee of the British Association at Edinburgh in 1892, when the mercurial standard was definitely adopted. At this meeting of the committee, representatives of American, French and German physicists (including von Helmholtz) were invited to sit as members. The methods employed in these comparisons and the forms of the standards are original with the Reichsanstalt. The new forms and methods admit of a combined accuracy and convenience not previously attained.

In addition to the work done in electrical resistance, the investigation of the silver voltameter and the electromotive force of standard Clark and Weston cells has been highly productive of useful results for the other two fundamental electrical measurements. Much remains to be done in this latter direction, for the electromotive force assigned to the Clark and Weston cell, even in the latest report of the Reichsanstalt, is derived from measurements by the silver voltameter, while the electrochemical equivalent of silver is in doubt to a greater extent than the electromotive force of the Clark cell.

Perhaps the best indication of the valuable work of the Reichsanstalt is to be found in the annual 'Thätigkeitsbericht.' This report of the year's activity is published in the 'Zeitschrift für Instrumentenkunde,' and the reprint for 1899 forms a pamphlet of twenty-five large, closely printed pages. The following abstract will

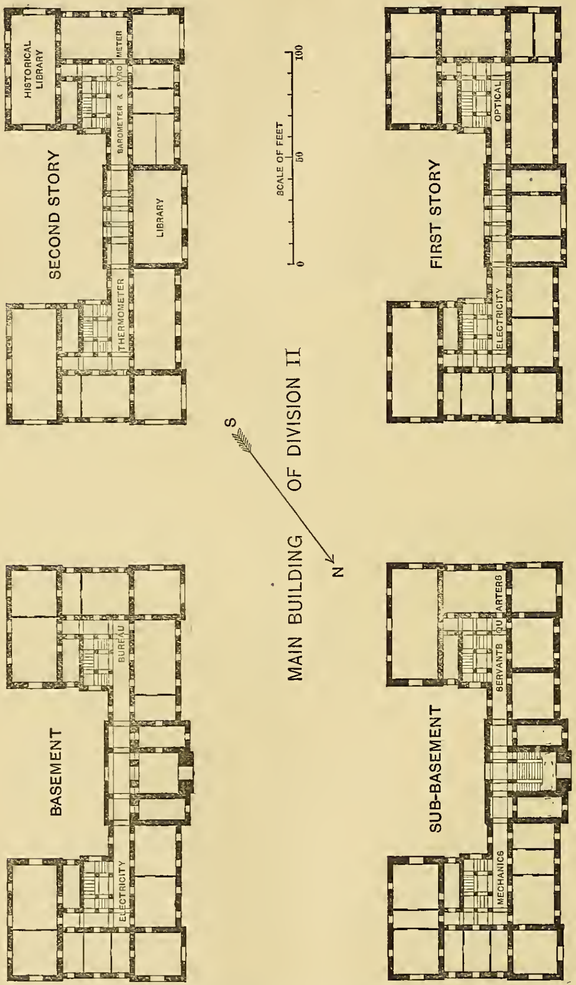

Fig. 2.—Floor Plans of Main Building. Division II.

convey some impression, though an imperfect one, of the extent of the work accomplished :

FIRST (PHYSICAL) DIVISION.

I. *Work in Heat.*—Determination of the density of water between 0° C. and 40° C.

Determination of the pressure of water vapor at low temperatures.

Determination of the pressure of water vapor near 50° C.

Investigations of thermometers for temperatures between 100° and 200° C.

Investigation of the nitrogen thermometer with a platinumiridium bulb for very high temperatures.

Investigation of thermometers for low temperatures.

Determination of the thermal and electrical conductivity of pure metals. (These determinations are to be extended down to the temperature of liquid air and up to 1,000° C.)

Investigations with the Fizeau-Abbe dilatometer.

Investigation of the transmission of heat through metal plates.

II. *Work in Electricity.*—Comparison of the normal wire resistances of Divisions I and II.

Determination of the capacity of an air condenser.

Comparison of the standard cells of Divisions I and II.

Determination of the conductance of water solutions with a higher degree of accuracy than has been attained hitherto, especially with dilute solutions.

III. *Work in Light.*—Investigation with electrically heated black bodies.

Proof of Stefan's law between 90° and 1,700° absolute temperature.

Determination of the relation between the intensity of light and the temperature.

Measurement of radiation in absolute measure.

Determination of the distribution of energy in the spectrum of black bodies.

Determination of the distribution of energy in the spectrum of polished platinum and other substances ; also their reflective power.

SECOND (TECHNICAL) DIVISION.

I. *Work of Mechanical Precision.*—Investigation of the errors of length and of the division of 300 scales, tubes, etc.

Coefficient of expansion of 18 bars, tubes and wires.

Verification of 86 tuning forks for international pitch.

Construction of a new transverse comparator.

Study of the variations of angular velocity of rotating bodies.

II. *Electrical Work.*—Calibration of direct current apparatus, 183 pieces.

Calibration of alternating current apparatus, 58 pieces.

Examination of other electrical apparatus, 76 articles.

Examination of accumulators, primary elements and switches, 37 articles.

Examination of insulating and conducting materials and carbons, 23 articles.

Installation of storage cells for a current of 10,000 amperes.

Installation of small storage cells for an electric pressure of 20,000 volts.

Installation of alternating current instruments for measuring potential difference up to 500 volts and current up to 100 amperes.

Examination of 29 samples of alloys for specific resistance and temperature coefficient.

Examination of 126 samples of insulating materials with an electric pressure up to 800 volts.

Verification of single resistances, 123 samples.

Calibration of 33 resistance boxes, compensation apparatus, etc., containing 1,153 resistances.

Comparison and verification of 133 standard cells—111 Clark and 22 Weston elements.

Determination of the ratio Clark 15° C. to cadmium 20° C., and Clark 0° C. to cadmium 20° C. with a large number of standard cells.

Examination of 21 samples of dry and storage cells.

Calibration of 25 galvanometers to measure high and low temperatures with thermal elements.

Magnetic examination of 25 samples of iron and steel.

Investigation of the difference between the continuous and the discontinuous magnetization of steel.

Investigation of the influence of repeated heating on the magnetic hardness of iron.

III. *Work Relating to Heat and Measurement of Pressure.*—Calibration of 18,777 thermometers.

Examination of 4 safety appliances and benzine lamps.

Calibration of 317 thermal elements.

Verification of 9 manometers and 22 barometers.

Testing of 190 samples of apparatus for petroleum investigations.

Testing of 3,210 samples of safety rings and plugs.

Testing of 32 samples of indicator springs.

IV. *Work in Light.*—Testing of 119 Hefner lamps for photometric purposes.

Testing of 189 incandescent lamps.

Testing of 143 gas and other lamps and adjunct appliances.

Investigation of the relation between the temperature of sugar solutions and their rotary power on polarized light.

Investigation of quartz plates for the examination of sugars.

Determination of 100 points in the normal Ventzke scale for sodium light.

Especially careful collection of sugars from Germany, Austria, France, Russia and North America for the investigation of specific rotatory power.

V. *Work in Chemistry.*—Continuation of the study of the solubility of important salts.

Electrolysis of platinic chloride and the migration of the ions.

The quantitative determination of metallic platinum.

Investigation of liquids for use in thermometers to measure low temperatures.

In addition to the above work attention is drawn to the fact that there are two institutions for the calibration and certification of thermometers under the control of the Reichsanstalt, one at Ilmenau and the other at Gehlberg. During the last ten years the institution at Ilmenau has tested in round numbers 350,000 thermometers.

The number of persons employed in the Reichsanstalt the past year was 87.

V. A LESSON FOR US.

If Germany has found it to her scientific and industrial advantage to maintain the Reichsanstalt, and is proud of what it accomplishes; and if Great Britain is so impressed with the success of the institution that she has decided to imitate it, it is surely the part of wisdom for the United States to move in the same direction. It is therefore very gratifying that at the suggestion of Secretary Gage a bill was introduced in the last Congress to establish a National Standardizing Bureau, and that the Committee on Coinage, Weights and Measures reported unanimously and strongly in favor of its passage. So great is the importance of this movement from the point of view of science, of national pride and of the higher interests of industrial pursuits, that the effort so happily begun to secure suitable legislation should be repeated with redoubled force and enthusiasm. Some of the reasons for making this effort one does not need to go far to seek.

In the first place the scientific interests to be served are certainly as great as in any other country in the world. Science is cultivated here with increasing assiduity and success. We are no longer content to follow in the footsteps of European savants and modestly repeat their investigations. Original work of a high order is now done in many American universities; but the difficulties under which university instructors prosecute research are even greater here than in Germany, and we are still compelled to go to Europe for most of our standards. As a result, inventions of an almost purely scientific character originating here have been carried to perfection in the Reichsanstalt, and Germany gets the larger part of the credit. I need only instance the Weston standard cell, which has been so fully investigated at the Reichsanstalt, and the alloy 'manganin,' which the same institution employs for its standard resistances after a searching inquiry into its properties. Both of these are the invention of Mr. Edward Weston, one of the Past-Presidents of this Institute. So long as there is no authoritative bureau in the United States under Federal control, and presided over by men commanding respect and confidence, we must continue 'to utilize the far superior standardizing facilities of other governments.' It is true that science knows no nationality, but the scientific workers of any nation can serve their own country better if they are not compelled to obtain their standards and their best instruments from distant parts of the globe. America has the cultivation in physical science, the ability on the part of her investigators and the inventive faculty to do work in a national institution that we shall not be ashamed to place by the side of Germany's best products. The establishment of a national institution for physical and technical purposes can not fail to foster a vigorous and healthy growth in science, to which we already owe so much of our national prosperity and renown.

In the second place Congress should be stimulated to take action because of national pride. It is not creditable for a capable and self-reliant nation to continue to depend on foreign countries for its standards of measurement, for the certification of its instruments and for the calibration of its normal apparatus for precise work. Different departments of our Government and offices under its control must at present appeal to foreign bureaus for the certification of their standards and instruments of precision. The first day the writer spent at the Reichsanstalt he was consulted with reference to an extended correspondence between the Director of the technical division and the officials of the Brooklyn Navy Yard relative to the calibration of a large number of incandescent electric lamps for use in our Navy department. The spectacle of a Government bureau going to a foreign imperial institution for standards in an industry whose home is in the United States is a humiliating one. Yet the proceeding was entirely proper and justifiable because there is in this country no standardizing bureau for the purpose desired. Are the representatives of the American people willing to have this state of affairs continue?

Again, the higher interests of the industrial utilization of scientific knowledge require the establishment in Washington of an institution similar to the Reichsanstalt, and in no degree inferior to it. We are an inventive people and may justly claim renown in the prompt and efficient utilization of the discoveries in physical science. It is highly improbable that a practical limit has already been reached in the field of applied physics. We are not estopped from making further discoveries. Still, it may be affirmed with confidence that the most important and promising work to be done, except in the rare instances in which genius makes a brilliant discovery, will consist in the more perfect adaptation of known physical laws to the production of useful results. It is precisely this field which has not been extensively cultivated as yet in the United States. We have explored the surface and presumably gathered the largest nuggets and the most brilliant gems. To increase the output we must now delve deeper and scrutinize more closely. To drop the metaphor, what will be required for future preeminence is the more intensive and exhaustive study of the scientific conditions in the industrial utilization of physical laws. This study will require the best talent of our technical schools, aided and supported by an authoritative national institution, itself far removed from patents and commercial gains, but jealous of our national renown and eager to cooperate with manufacturers for the sake of national prosperity.

Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism and the failure to utilize to the fullest extent the lessons taught by science; while Germany, once the country of dreamers and theorists, has now become eminently practical. Science there no longer seeks court and cloister, but is in open alliance with commerce and industry. This is substantially the view taken by Sir Charles Oppenheimer, British Consul-General at Frankfurt, in a recent review of the status and prospects of the German Empire.

The Reichsanstalt is the top stone of Germany's scientific edifice. It has also contributed much to her industrial renown.

It is necessary to cite only her manufactures involving high temperatures, such as the porcelain industry, to appreciate the help afforded by the Reichsanstalt. The methods and instruments elaborated there for the exact measurement of high temperatures constitute a splendid contribution toward industrial supremacy in those lines. The German government sees with great clearness that the Reichsanstalt justifies the expenditure made for its maintenance, not by the fees received for certifications and calibrations, but by the support it gives to the higher industries requiring the application of the greatest intelligence. In this connection it should be thankfully acknowledged that the services of this imperial establishment are placed at the disposal of foreign institutions of learning with the most generous liberality. The charges for calibration are only about one-fourth the expense incurred in making them, but the support thus given to German makers of instruments of precision, by increasing their foreign orders, is deemed a sufficient return for the services rendered.

HENRY S. CARHART.
UNIVERSITY OF MICHIGAN.

PLANT GEOGRAPHY OF NORTH AMERICA.

I.

THE PHYSIOGRAPHIC ECOLOGY OF NORTHERN MICHIGAN.

I. *The Physiographic Standpoint in Ecology.* —Warming's classification of plant formations, doubtless the best we have, is inadequate to explain many of the facts that are brought out in field study. While water is certainly the most important single ecological factor, it cannot be made the only standard for classification; the difference between the flora of drained and undrained swamps is not a question of water content, but probably of drainage; a heath and a moor have similar ecological adaptations, but are very diverse as to water content. A classification to be correct must also be dynamic and must present the flora of a district from the standpoint of its past and future, thus dealing with genetic relationships. A classification which runs parallel with the normal physiographic changes in a region meets all these needs and presents the flora as a unit, taking account of all the interrelations. The various ecological groups or plant formations are presented in a historical sequence, ending in a normal climax or culminating type, corresponding to the base level of physiography.

II. *Application of the Physiographic Standpoint to Northern Michigan.*—A. Progressive Development of Plant Formations. The vast majority of natural formations are developing toward the climax type, which for Northern Michigan is a mixed forest in which the hemlock, beech and sugar maple dominate. At the outset the conditions may be xerophytic or hydrophytic (using these terms in the original sense as referring to the water content of the soil).

1. Xerophytic to Mesophytic. In a young region, xerophytic formations are found commonly on hills and along exposed shores. The development on the hills is widely variant; perhaps the climax condition is first reached on clay hills, because of the ease with which water is held and humus formed. Sand hills reach mesophytic conditions relatively late, because they possess opposite physical characters. Rock hills commonly have a slow development because disintegration and soil formation are first necessary; a lichen vegetation first appears, then a crevice vegetation, finally other stages, closing with the mesophytic forest. Rock hills of course vary greatly among themselves, the development being almost inconceivably slower on granite or quartzite than on limestone or shale. Xerophytic shores are much more uniform, having first an annual, then a perennial vegetation, and finally the several forest

types in succession; often a dune phase is interposed in this series, immediately after the beach.

2. Hydrophytic to Mesophytic. Hydrophytic areas are common in young regions and are either drained or undrained. Undrained lakes and swamps are very common at first, but are very rapidly filled by vegetation, so that one formation rapidly follows another from the lake to the forest; zonal arrangement is usually found in these places. Drained swamps and rivers often increase as a region grows older; progressive development is best seen on the flood plains, where the order of succession is commonly well marked and rapid, culminating in the very highest type of mesophytic forest. There are often hydrophytic shores along the lakes, usually in the less exposed places; their history is much like that of a swamp.

B. Retrogressive Development of Plant Formations. Retrogression is commonly local or evanescent. It is best seen along lake or river bluffs, where constant erosion causes the destruction of mesophytic formations. When erosion ceases, progressive movements begin, culminating again in mesophytic floras. Retrogressive movements may also be caused by crustal movements, changes in climate, or through the action of man.

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II.

THE RELATIONS OF THE NORTH AMERICAN FLORA TO THAT OF SOUTH AMERICA.

In my paper on 'The Relation of the Flora of the Lower Sonoran Zone in North America to the Arid Zones of Chile and Argentine,' attention was called especially to discussions by Gray and Hooker and by Engler on the presence of North American or boreal floral elements in South America. The species considered in the two citations were chiefly alpine and mountain xerophilous plants of the Rocky Mountain Region and the arid Southwest (the latter especially by Engler) which occur in the Mexican Cordilleras and in the boreal altitudes of the tropical Andes, becoming more generally distributed in the extra-tropical Andes and the higher plains of Chile and Argentine. My own paper attempted to show that a very significant number of the genera representing the most extremely xerophilous elements of the enclosed desert plateaus and valleys of the Lower Sonoran Zone, reappear in correspondingly arid regions far south of the equator, and that the intervening territory contains these rarely or not at all. It further discussed the problems of distribution between the two regions, going in some detail into a discussion of certain species which illustrate the case especially well.

In this paper the purpose will be to point out the generally known and accepted facts of relationship between the floras of North and South America as illustrated in all the floral elements represented in both, emphasizing more particularly the elements which I have studied in some detail which furnish additional evidence for conclusions already suggested rather than offer a new solution to the more difficult problems of distribution.

It may be said as an elementary observation, that if we consider only the present aspects of plant life, and conceive the floral zones of North and South America to be due to and lie coincident with zones of latitude, we should have in the two Americas only the tropical zone in common, shading off into the north and south zones of lower temperature, in which the likelihood of a mixture of boreal and austral elements of any two corresponding boreal or austral zones would grow less with increasing proximity to the poles. The question of distribution would be chiefly one of distance which might or might not be overcome by any of the various agencies operating now. In other words, we should expect endemism to increase with latitude and a consequent minimum of forms common to two corresponding zones. As a matter of fact, however, these simple conditions are wholly changed because of the existence of north-south zones of elevation, shading off vertically from tropical to Arctic Alpine, and cutting through the tropical and sub-tropical latitudinal zones at right angles, and so approximating a connecting bridge between boreal and austral zones. Here, again, if we take any given era in the history of vegetation and assume the north-south zones to be continuous, the results of distribution could be fairly predicted.

But in considering the relations of the floras of the two continents, no fact stands forth more prominently than this, namely, that we have to deal largely with the geological and climatic changes which have taken place during the time since the flora of the earth began to assume its present aspect, and to possess its present specific content. For many elements of vegetation which still persist we could reasonably go back as far as the Eocene Tertiary, although much of what are called *Peculiar West American Elements* must have developed at a very much later period. Assuming, however, the Eocene Tertiary as the starting point, some very important conditions and changes in the relations of the two continents may be pointed out, which would influence the development and the distribution of plant life most profoundly. These are to be borne in mind when we seek to explain the floral relations of North and South America. Such, for example, are the following:

1. At the beginning of the Tertiary period, a large part of Western North America was at sea level. The Rocky and the Sierra Nevada Mountains ranged from 3,000 to 5,000 feet in elevation. West America was separated from Atlantic America by a wide sea. By the end of the Tertiary Period the elevation of West America was tripled, bringing the mountains to at least their present height and elevating the plains and Great Basin region.

2. During the Eocene and Miocene eras, Central America was submerged, thus separating the two continents.

3. With the beginning of the Tertiary Period, the Andes stood but little above sea level. A Cretaceous sea had extended along their eastern front from Venezuela to Argentine, separating the Brazilian region from the Andean. By the close of the Tertiary, the Andes had emerged as much as 20,000 feet on their east front, and the region at their eastern base stood emerged from the sea.

4. During some portion of the late Tertiary upheaval, or subsequently, South America was joined to Cuba and probably to Florida. There is reason to believe that at a similar period the land masses of Mexico and the Californian region included the now isolated islands lying to the westward, thus making a broad highway for distribution between the American continents.

5. The climate of the Eocene and Miocene eras in North America was mild, and permitted an extension of warm-temperate flora as far north as Alaska.

6. In the Pleiocene era the climate became cooler. Subsequently in the Glacial Pleistocene, the encroaching ice-sheet drove all plant life far southward. As the Andes were at their present height approximately, and as the Central American highlands in common with the Mexican Cordilleras and the Rocky Mountains were in a period of upheaval, probably greater than the present, a highway was opened to the south for Alpine and Arctic-Alpine elements, as well as for the southward migrating warm temperate flora.

7. The sequence of upheavals which

brought the Great Basin and the arid Southwest from sea level or submergence to their present elevation, also witnessed the development of a vigorous flora which has continued to occupy these regions, containing many of the peculiarly West-American groups. The same sequence of upheavals may have opened up similar areas southward at the east of the Andes upon which this flora could also extend, though subsequently excluded by tropical conditions more like the present.

A vegetation developing under such conditions as those cited above, would have had a most varied, not to say precarious history, now reaching far northward in luxuriance, now driven back by the encroaching ice-sheet; now, a species distributed over a wide area, and again only the remnants of it in widely separated areas. Here, a terrain covered with a varied vegetation which with the next change of conditions becomes a sea or an arid basin. Not only were these tremendous changes going on in the make-up of the two continents and their relations to each other, but conditions existed which related each to other land masses, whereby floral elements were received which were to play a part in the subsequent development of the floral history. Such was the contact of the North American region with Europe and Asia, and of South America through the Antarctic Continent with Australia, New Zealand and probably South Africa.

In taking up a more specific analysis of the floral elements common to both Americas, we must therefore bear in mind certain physical conditions involving not only those which prevail at the present time, but also the varying conditions, which have prevailed since at least the middle Tertiary period.

First, the north-south zones of elevation have interruptions of distances great enough to offer a very efficient check to north-south distribution, greater in the case of Arctic Alpine conditions, less in the transition zone and greatest of all in the case of extreme xerophilous elements of enclosed desert basins and valleys.

Second, we must allow for fluctuations in elevation and depression of the continental axis, especially in the region of juncture of the two continents, and consequent changes in relation of the two land masses. These fluctuations would extend back over a period in which the flora of the earth was undergoing tremendous changes, migrations and adjustments, all of which would be influential in the final setting.

Third, as to the sources of elements which might be brought into the field of influence, we must allow for the intimate relation of North America to the Eur-Asian continent whereby floral elements were shared in common, and for the early isolation of the South American continent from Antarctic land masses, although the Antarctic flora of South America does show a community of elements with South Africa, Australia, New Zealand and Antarctic islands.

Fourth, the prevalent southward pressure of elements is to be associated with glacial influences which may well have been most powerful in driving so great a boreal element southward. This would be all the more notable in the case of the warm temperate xerophilous elements, which have shown such vigor of development and encroachment, constituting the most characteristic and unique elements of the New World flora.

The relationship of the floras of North and South America will be discussed under the following heads: 1st, The Gulf Zone Neo Tropical, 2nd, The Alpine and Arctic-Alpine, and 3rd, the Warm-temperate and Semi-tropical xerophilous elements embracing (*a*) high plateau and mountain forms of the Transition and Upper Sonoran Zones; (*b*) enclosed basin and valley forms of the

Lower Sonoran Zone; (*c*) semi-tropical xerophilous forms of Gulf Zone distribution.

. THE GULF ZONE NEO-TROPICAL ELEMENT.

The territory embraced within the Gulf Zone includes those regions which have had a common history in the development of their flora during the fluctuating geological conditions of the Gulf area. While this zone is but a part of the greater Neotropical, its association with a common sequence of geological changes has, as Engler* thinks, given it a degree of distinctness from the Brazilian region. The regions so associated are: The coast lands, plains and sub-Andean parts of Guiana, Colombia and Venezuela; the Central American region except the tierra templada, the tierra frias of Guatemala and the isolated elevations (above 8,000 feet) in Nicaragua and Costa Rica; the tierra caliénté of Mexico which on the west reaches northward to include the lower Colorado Valley in California and Arizona, and embraces the point of the lower California peninsula, and on the east coast is a narrow belt extending northward to the lower Rio Grande Valley in Texas, the lower third of Florida and the greater and Lesser Antilles. On the west, the tropical elements pass vertically rather gradually into the vegetation of the tierra templada of Mexico and Guatemala, and at the north a semitropical Gulf strip from the mouth of the Rio Grande to and including upper Florida, marks the transition to the subtropical flora of the Gulf States which, though distinctly a part of the Atlantic Coast Plain or Austro-riparian flora, has numerous elements of tropical extraction, as, for example, the *Palmæ*, the *Tillandsias*, some *Euphorbiaceæ* as *Argithamnia*, *Acalypha*, *Sebastiana*, *Stillingia* and *Hippomane; Bignonia*, *Phoradendron*, *Persea* and many others.

At the west, the northward extension of tropical flora is checked by xerophytic conditions, so that a very meager tropical element reaches the United States in that quarter. On the other hand, the free northward extension to the Florida province, whose physical conditions favor a purely tropical flora, has been retarded by interruptions in the continuity of land masses, so that while the flora of South Florida is not a part of the Austro-riparian and sub-tropical, it is comparatively meager in South American species. It has, however, many elements in common with the Antilles. The sharp distinction between South Florida and the remaining Gulf States and North Florida, is shown in the following data compiled by Drude* from *Chapman's Flora*. "There are 360 species in Florida which do not extend north of the 29th parallel; of these 169 belong to 132 genera which have no distribution further northward, or 16 families reach a northern limit in this peninsula."

It is interesting to note that some of the genera cited above and others, as marking the transition from tropical to sub-tropical United States, also extend into extra-tropical South America, namely, to Argentine. Those cited by Engler† are *Argithamnia*, *Bignonia*, *Lippia*, *Chaptalia* and *Galphimia*, to which may be added many *Amaranths* and others. But as this element consists so largely of xerophytic and halophytic species, I have discussed it under the head of semi-tropical xerophilous forms of Gulf zone distribution.

2. ALPINE AND ARCTIC-ALPINE FLORAL ELEMENTS IN SOUTH AMERICA.

As previously stated, the extension of an elevated continental axis from Alaska to Cape Horn makes an approximately continuous boreal zone across the equatorial regions. This continuity has fluctuated

* Entwickelungsgeschichte der Pflanzenwelt, II., p. 197.

* Pflanzengeographie, 511.

† Entwickelungsgeschichte II., p. 189.

greatly during the period of development of the plant life of the present era, and with profound effect in molding the present conditions. As a highway for north-south distribution of the boreal elements, its efficiency has of course varied. As at present constituted, it is interrupted by a stretch of moist tropical conditions for a distance of some 10 degrees of latitude, namely, from the southern downfall of the Guatemala highland, 15° N., to the Colombian Andes, 5° N., at an altitude of some 12,000 feet. Practically, however, one must allow for a degree of continuity even over this stretch as offered by the highest peaks of Costa Rica, Nicaragua and even in the Panama district. An analysis of the floral elements of this north-south Arctic and Arctic-Alpine zone shows the following interesting phenomena :

First, that the flora of the Rocky and Sierra Nevada Mountains above the Transition zone, the Mexican Cordilleras in the tierra frias (from 8,000 to 12,000 feet), of the Guatemalan tierra frias and of the tropical Andes above 12,500 feet, and the extra-tropical Andes and highlands, is one of Northern extraction, abounding in genera associated with the colder zones of North America and Eur-Asia. Such, for example, are: *Ranunculus*, *Anemone*, *Berberis*, *Geranium*, *Spiræa*, *Geum*, *Rubus*, *Ribes*, *Saxifraga*, *Hydrocotyle*, *Gaultheria*, *Vaccinium*, *Veronica*, *Eritrichium*, *Gentiana*, *Polemonium*, *Hieracium*, etc.

Second, that while possessing very many genera in common, by far the greater per cent. of species in the Mexican Cordilleras are endemic, as are those of the Alpine Andes. This points to a long continued and effective isolation of the Mexican and South American Andes from each other and from the Rocky Mountains.

Third, that of Arctic-Alpine genera those are most common which belong to the element common to the Himalayan and East-Asiatic regions and the Rocky Mountains from Alaska to Colorado; that such genera occur sparingly in the Mexican and tropical Andes, and then with endemic species; that there is an increase of this element in the extra-tropical Andes toward the Straits of Magellan. Here is to be noted that certain species of the Rocky Mountain Arctic-Alpine region reappear in the extra-tropical Andes toward the southern extremity of South America, being, so far as known, absent from the Mexican and Tropical Andes. Among these are: *Gentiana prostrata*, *Trisetum subspicatum*, *Primula farinosa* and var. *magellanica*; *Draba incana* = *Draba magellanica*; *Alopecurus Alpinus* = *A. antarcticus*; *Saxifraga cespitosa* = *S. cordillerarum*; *Polemonium micranthum* = *P. antarcticum*; *Collomia gracilis*.*

3. WARM TEMPERATE AND SUB-TROPICAL XEROPHILOUS ELEMENTS COMMON TO NORTH AND SOUTH AMERICA.

These elements of flora common to both Americas deserve special emphasis. They embrace for the most part, the flora of the arid regions of the western and southwestern states and North Mexico. This flora occupies the mountain slopes of the transition zone, the plains and plateaus of the Upper Sonoran and the hot deserts of the Lower Sonoran zones. This area has been the field of development of many groups peculiarly American. It is the region of xerophytic composites, *Nyctaginaceæ*, *Polygonaceæ-Eriogoneæ*, *Onagraceæ*, *Amaranthaceæ-Gomphreneæ*, *Malvaceæ*, *Borraginaceæ-Eritrichiaeæ*, Gilias, the Yucca and Agave kinships and the *Cactaceæ*.

When this peculiar flora was in the vigor of its development and occupation of new territory, the climatic conditions seem to have exerted a pressure to the southward which geological conditions favored, with

* This list is taken mostly from Engler's Entwickelungsgeschichte, II., p. 256.

the consequence of carrying a great richness of forms into the South American region.

There has also apparently, been an encroachment of elements developed in South America northward, as shown in the *Loasaceæ* (Mentzelias) and species of *Prosopis*, whose great development occurs in the Chilean and Argentine regions respectively.

Greater details of distribution may be discussed as follows: (1) The mountain forms; (2) Forms of the arid basins and valleys of the Lower Sonoran Zone; (3) Subtropical xerophilous forms of Gulf Zone distribution.

(1) *The Mountain Xerophilous Sonoran Elements.*

In North America this element occupies the arid mountain slopes and high plateaus of the Transition and Upper Sonoran zones, extending also into the deserts of the Lower Sonoran. Its southward distribution has been favored by the existence of an arid zone comprising the moistureless west slopes and enclosed plateaus of the Mexican and Tropical Andes, lying mostly below the altitudes of Alpine conditions. Both the aridity and continuity of this zone have varied with the changes in elevation, and in all probability a north-south distribution of xerophilous mountain elements was much easier at some earlier period than at present. The facts of endemism are much the same for the North American, Mexican and Andean regions as in the case of Alpine forms.

Illustrations of this element include Xerophilous ferns of the genera *Gymnogramme*, *Pellœa*, § *Eupellœa* and § *Cincinalis*, *Notholœna* and *Cheilanthes*, many of which range from West Texas, New Mexico, Arizona, etc., to Mexico, Guatemala and in the South American Andes to Chile; of the *Leguminosœ: Astragalus*, *Dalea*, *Lupinus*, *Trifolium*, *Vicia* and *Lathyrus; Rosaceœ-Quillajeœ*, *Onagraceœ: Œnothera*, *Gayophytum*, *Chammissonia*, *Lavauxia*, *Godetia*, and *Boisduvallia; Artemisia*, *Perezia* and *Astereœ-Soladigineœ* of the *Compositœ;* many *Cactaceœ; Borraginaceœ-Eritricheœ; Gilia* and many others.

(2) *Lower Sonoran Elements.*

These forms are of special interest because they include the most extreme xerophytes and halophytes occupying the most arid deserts of both North and South America *in the extra-tropical regions*, and mostly unrepresented in the long stretch of moist, tropical and high mountain areas between. Such are the *mimoseœ*, *Prosopis*, § *Strombocarpa* with 3 species in Argentine, and 3 Lower Sonoran species of west Texas, north Mexico and westward; § *Algarobia* with 19 species mostly Argentine; *Polygonaceœ-Eriogoneœ* with eleven Lower Sonoran genera (except some Eriogonums) and the peculiar subgenus *Chorizanthopsis* of the *Chorizanthes*, endemic in Chile, and three species common to both zones; namely, *Oxytheca dendroidea*, *Chorizanthe commissuralis* and *Lastarriœa chilensis*, all originally from the Californian region; *Frankeniaceœ*, with the very distinct *Frankenia jamesii* of the west Texas region, *F. Palmeri* of the southern California region, *F. triandra* of the Puna region six nearly allied Chilean species, one of which is in California and Arizona and *Nederleinia juniperoides* of the Argentine Salt Steppes, more nearly related to the Lower Sonoran than to the Chilean species. These, apparently, constitute remnants of a previously widespread development.

The *Zygophyllace* also present an excellent illustration of the phenomena of distribution here considered. Perhaps no plant is more prominent as an indicator of the Lower Sonoran Zone than *Larrea mexicana* which is exceedingly abundant and widespread over this zone. No representatives of this genus occur between the southern limits of the Lower Sonoran in Mexico, and the Andes and Salt Steppes of Cardoba and

Mendoza southward to the Rio Colorado in South America, where three species occur which are sharply distinct from each other and especially from *Larrea Mexicana.* One of these South American species, *L. divaricata,* is described as covering great areas of Cordoba and Mendoza as *L. Mexicana* covers areas in Texas, Arizona and Northern Mexico.

From these and other illustrations, it is necessary to conclude that we are here dealing with forms which were connected by a remote ancestry, which flourished at a time and under conditions which permitted a more general distribution. We may possibly ascribe these condition to a certain stage in the elevation of land masses along the continental axis. At any rate, the fluctuations in climatic and geological conditions since the Tertiary Period would have very different conditions of distribution and relationship from those we observe now.

On the other hand, that the same species may occur in both these widely separated areas, and nowhere between, indicates the energy of certain agencies acting now and in spite of climatic and geological barriers, *e. g., Fagonia cretica, Frankenia grandiflora, Munroa squarrosa* and the three previously cited species of *Polygonaceæ-eriogoneæ.*

(3) *The Semi-tropical xerophilous forms of Gulf Zone Distribution.*

In discussing the Neo-tropical and semi-tropical elements, attention was called to a Gulf Zone distribution between extra-tropical regions. The forms involved here are the less extremely xerophytic species of the warmer and less arid portions of the Lower Sonoran Zone; *e. g.*, the Rio Grande Plain in Texas and Mexico below Eagle Pass. Such species occur also in the xerophytic areas of Colombia, Venezuela, Guiana, Brazil, Uruguay, Paraguay and Argentine, and in similar areas of the Antilles. Some are undoubtedly sea-coast species. The following are illustrations:

Sida leprosa: Uruguay, Patagonia, Argentine, Cuba, Lower Sonoran Zone (even north to Washington).

Sida hastata: Argentine, Uruguay, Mexico, Texas, Arizona.

Sida Anomala: Mattogrosso, Uruguay, Argentine, Bolivia, Cuba, Florida, Texas, Mexico.

Cienfugosia sulphurea: Southwest Texas, Mexico, South Brazil, Paraguay.

Spergularia plattensis: Texas to California, South Brazil.

Polygala paludosa: Brazil, Paraguay, Louisiana and Texas.

The *Amaranth-Gomphreneæ* are prevailingly of the Gulf Zone distribution, especially *Frœlichia, Alternanthera* and *Gomphrena*, but in the last case, mention should be made of the massing of species in Southern Brazil and Argentine, and their comparative absence northward until the Mexican plateau is reached, where, again, are many species, mostly distinct from the South American forms. This fact would suggest the propriety of including *Gomphrena* in the category of genera like *Larrea, Frankenia, Spirostachys, Malvastrum, Chorizanthe,* and others, in which the present conditions of distribution and kinship point to them as remnants of a previous general distribution over territory not now adapted to their needs.

SUMMARY.

Reviewing the floral relations of North and South America as illustrated in the foregoing instances, we may say that the phenomena of distribution agree fairly with the record of physical conditions which have succeeded each other and those which still exist, and upon which we might almost *à priori* have predicted an analogous set of distribution phenomena. In this relationship we may distinguish three categories of distribution:

(1) Those due to the conditions of hu-

man civilization, commerce, etc. This has resulted in placing the same species in similar regions of both continents, as, for example, *Fagonia cretica* in Lower California and Chile; *Munroa squarrosa*, western plains of North America, plains of Argentine and high plateaus of Chile and Bolivia; *Frankenia grandiflora*, Southern California and Arizona, coast lands of Chile; *Oxytheca dendroidea*, *Lastarriæa chilensis*, and *Chorizanthe commissuralis*, all in Southern California and Western Chile.

(2) Those due to the operation of natural causes acting under present conditions of climate, geology, etc. Under this head may be cited such species as *sida leprosa*, *hastata*, *anomala*, *Cienfugosia sulphurea*, *Spergularia plattensis* and, in general, elements of Gulf zone distribution; also certain elements which still find a pathway along the continental axis, including some alpine and mountain xerophilous genera.

(3) The third category of distribution would include those phenomena due to geological and climatic changes acting through long periods. Under this head are included the elements of greatest significance in the relationsip of the North and South America floras. The endemic boreal flora of the Andes, the equally endemic boreal flora of the Mexican Cordilleras, and genera with sharply distinct species or sub-genera in the arid extra-tropical regions of both continents, which may be called remnant elements.

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NAMES OF ANIMALS PUBLISHED BY OSBECK IN 1765.

In 1757, Peter Osbeck, a pupil of Linné published in Stockholm a work entitled: 'Dagbok öfver en Ostindisk resa aren 1750–1752.' The work* was subsequently translated into several languages, with dates of publication as follows: in German, 1765 (Rostock), and 1772 (Leipzig), two editions; in French 1771; in English, 1771. Of these translations I have examined the German, 1765, and the English. The latter translation is not from the original, as we learn from its editor, but from the German, the latter having had the advantage of revision by Osbeck, who, we are told, made some additions to it.

On comparison of Osbeck's proposed names for the various species of animals discovered with the tenth and twelfth editions of Linné's *Systema Naturæ*, one is struck by the number which are not referred to in those works; and, as far as I can learn, these omissions have not been included in later works in most instances. It is for the purpose of bringing them to the attention of naturalists that I offer the present notes.

Such of Osbeck's names which are tenable should date from the 1765 translation which follows the tenth edition of Linné. The pagination noted herein refers to that volume.

MAMMALIA.

Cervus javanicus. Page 357. Java.

This is, probably, the *Tragulus* (= *Moschus*) *javanicus* Gmelin, 1788. The synonymy should be *Tragulus javanicus* (Osbeck), 1765, = *Moschus javanicus* Gmelin, 1788.

AVES.

Sitta chinensis. Page 326. China.

The *British Museum Catalogue of Birds* gives as a synonym of *Sitta cæsia*, a *Sitta chinensis* Viellot, 1819, but on reference to the *Nouv. Dict.*, v. XXXI, p. 332, it will be seen that Viellot gives Osbeck as authority for the name. Therefore *Sitta chinensis* Osbeck, 1765 and 1771, has priority over *Sitta cæsia* M. and W., 1810.

*The German translation is entitled: Reise nach Ostindien und China.

ANAS CHINENSIS. Page 340. China.

In the work just referred to there is a reference under *Anas hina* Gmelin, as follows: *Anas chinensis* Osbeck, Voy. II, p. 33. This is to the English edition, 1771. The synonymy should be *Anas Chinensis* Osbeck, 1765 (= *Anas hina* Gmelin, 1788).

Gmelin gives 'Osbeck (*it. 2*, p. 33)' as authority for *Anas hina;* but no such name occurs in the latter's book. It would thereford seem that *hina* is a misprint for *chinensis*.

DIOMEDEA ADSCENSIONIS. Page 382. Ascension Isld.

This is evidently synonymous with *Sula piscator* (= *Pelecanus piscator* Linné, 1758), with which species Osbeck compares it.

REPTILIA AND BATRACHIA.

TESTUDO JAVANICA. Page 128. Java.

From the description this is clearly a *Chelone*, and without doubt the same as *Chelone imbricata* (Linné), 1766. The latter thus becomes *Chelone javanicus* (Osbeck), 1765.

RANA CHINENSIS. Page 244. China.

Without doubt a *Bufo*, and referable to *Bufo bufo* (Linné). If the Chinese and Japanese representatives are not distinct races, then Osbeck's name would have precedence over Schlegel's *Bufo bufo javanicus*.

It is well to point out here that Boulenger (*Tailless Batrach. Eurl.* II, 265) has erred in referring Osbeck's *Rana chinensis* as a variety of *Rana esculenta* Linné. Osbeck says in his description, 'The body above warty,' which sufficiently indicates that the species is not a *Rana*.

Stone (*Proc. Ac. Nat. Sci.*, Phila., 183, 1899) states that *Rana chinensis* Boulenger (nec Osbeck) is quite distinct from *Rana esculenta*, in which event the former will require another name, which will be *Rana marmorata* Hallowell, 1860 (teste Stone).

LACERTA CHINENSIS. Page 366. China.

This lizard is probably identifiable from the description, which indicates that it belongs to the Geckonidæ. This name has been entirely overlooked by subsequent writers.

PISCES.

SQUALUS CANINUS. Page 102. Cape of Good Hope.

A synonym of *Carcharodon carcharias* (Linné), 1758, the great blue shark.

BALISTES CHINENSIS. Page 147. China.

Richardson (*Rep. Brit. Assoc. Ad. Sci.*, 201, 1845) refers this to the genus *Monacanthus*. However, in Bleecker (*Atlas*) and in the *Brit. Mus. Catal. Fishes*, Bloch is given as authority for the species; it is also described by Gmelin as *Balistes sinensis*. It should stand *Monacanthus chinensis* (Osbeck), 1765 and 1771 = *Balistes sinensis* Gmelin, 1788.

PERCA ADSCENSIONIS. Page 388. Ascension Isld.

Now *Holocentrus ascensionis* (Osb.) J. & E. The date for this species should be 1765. Note that the original name is *adscensionis*, not *ascensionis*.

SCOMBER GLAUCUS. Page 387. Ascension Isld.

Originally named *Scomber adscensionis* by Osbeck, 1757, but in the later translations 1765 and 1771 called *S. glaucus*, perhaps indicating it to be the same as *S. glaucus* Linné. Jordan and Evermann suggest its identity with *Caranx guara*.

In addition to the foregoing fishes Osbeck describes the following, whose names are not to be found in recent synonymy:

SPARUS CHINENSIS. Page 340. China.

Not the *Sparus chinensis* Lacèp.

SQUALUS ADSCENSIONIS. Page 388. Ascension Isld.

GOBIUS TROPICUS. Page 392. Ascension Isld.

SY[N]GNATHUS ARGENTEUS. Page 396. South Atlantic.

MOLLUSCA.

Chiton laeve. Page 80. Spain.

According to Linné, this is the same as his *Chiton punctatus*. Professor Pilsbry, to whom I showed Osbeck's description says it is probably the same as *Chiton olivaceus* Speng.

Cunnus chinensis. Page 247. China.

Osbeck does not state whether this bivalve is a fluviatile or a marine form, which makes his short description valueless. Were it a fresh-water form, the generic name *Corbicula* would be replaced by *Cunnus*. In the English translation this name is misprinted, *Conus*.

INSECTA.

Phalaena fenestrata. Page 269. China.

Osbeck proposes this name for the 'Phalæna plumata permaxima Orientalis oculata.' (Petiver, *Gazophylacii*, Pl. 8, f. 7), which, however, was named *Phalæna atlas* by Linné, 1758, Osbeck's name becoming thereby a synonym. The *fenestrata* Osbeck must not be confused with the *Phalæna fenestrata* Fabricius (*Syst. Ent.*, p. 641, 1775).

Papilio Lintingensis. Page 148. China.

This name will have to be adopted for the Indo-Chinese variety of *Junonia œnone* Linné, known as var. *hierta* Fabricius. The synonymy should be *Junonia œnone* Linné, 1758, var. *Lintingensis* (Osbeck), 1765 and 1771, = *hierta* Fabricius, 1798.

Apis rufa. Page 127. Java.

This is not the *Apis rufa* Linné, 1758. The description is, however, too meager to admit of identification of the insect.

CRUSTACEA.

There are two species described by Osbeck, which appear to have been omitted from synonymy. They are:

Cancer chinensis. Page 151. China.

Cancer adscensionis. Page 389. Ascension Isld.

William J. Fox.

Academy of Natural Sciences
of Philadelphia.

THE CARNEGIE MUSEUM PALEONTOLOGICAL EXPEDITIONS OF 1900.

Through the generosity of the founder of this institution, the Department of Paleontology has been able to continue the work begun in the season of 1899 in the Upper Jurassic formations of central Southern Wyoming. Mr. O. A. Peterson has had charge of the work in this region, and the splendid results obtained there are due to his skill and energy and to those of his assistant, Mr. C. W. Gilmore of the Wyoming State University, who joined Mr. Peterson in June and continued with him until the close of the season.

The investigations were confined chiefly to the Atlantosaurus beds on Sheep Creek, some twenty-five miles northeast of Medicine Bow, though some attention was also given to the Baptanodon beds in the immediate vicinity.

The chief results obtained were a complete pelvis with sacrum and one hind limb and foot of Diplodocus in position; one maxilla and a posterior portion of the skull and a number of series of vertebræ from various regions of the vertebral column. Numerous other isolated bones belonging to the same genus were also recovered. All this is most welcome material and will form an important supplement to the Diplodocus skeleton collected by the expedition of 1899, which we hope soon to be able to mount as a complete, though composite, skeleton. The fore limb and foot are at present the only important parts missing.

The party was quite fortunate in securing the greater portion of a skeleton of *Brontosaurus*, as well as considerable remains of *Stegosaurus* and a large carnivorous Dinosaur. The Baptanodon beds yielded a skull and anterior cervicals and ribs of Baptanodon. In all some ninety large cases of Jurassic vertebrates were taken up and packed, and will, it is hoped, not only add materially to the Museum collections, but also throw additional light on several of the many vexed questions regarding the structure and relationships of the several genera of Dinosauria to which the collections pertain.

In addition to the work carried on in the Jurassic, another field party, under the immediate charge of the writer, operated in the Laramie deposits of Converse County, Wyoming, and in the Tertiary of the same region and in Sioux County, Nebraska.

The early part of the season was devoted to an exploration of the Laramie in the region immediately adjoining that which afforded the writer all the mammals and most of the horned dinosaurs collected by him under the direction of the late Professor Marsh for the U. S. Geological Survey. The success that it was hoped might reward an exploration of these deposits was not entirely realized, though some important material was obtained, including a fairly representative series of Laramie mammals and the other vertebrate remains (fish, lizards, small dinosaurs, etc.) with which they are always found associated. One extremely interesting discovery in this connection consists of a portion of a dental plate with the teeth in position, of *Platacodon nanus*, described as a mammal by the late Professor Marsh. The mammalian nature of these remains has long been doubted, our material showing the teeth firmly ankylosed to the surface of the dental plate demonstrates conclusively the ichthyian nature of these teeth and that *Platacodon* should now be removed from the Mammalia to the Pisces. These remains and others will be figured and fully described by the writer in an article now in course of preparation, which will be published in the Museum *Bulletin* in the near future.

Among the more important dinosaurian remains there is a considerable portion of the skeleton of Claosaurus, with some 25 or 30 vertebræ in position. This specimen is believed to be unique among the known remains of dinosaurs, in that there are preserved in it, in the region of the anterior caudal vertebræ, an impression of the dermis which shows these animals to have been enveloped in life with a covering of small hexagonal plates or scales, something more than one-half inch in diameter. This, I believe, is the first accurate information we have as to the nature of the dermal covering of dinosaurs.

Late in July the Laramie was abandoned and operations were commenced in the Dæmonelix beds of the Upper Tertiary deposits near Harrison, Nebr. These deposits, made famous by Dr. E. H. Barbour of the Nebraska State University, are extremely rich in the remains of these imposing and perplexing fossils. A very complete series of Dæmonelix spirals and rhizomes were collected, as well as important mammalian remains from the same beds, and much valuable evidence secured, bearing directly upon the different species and phylogeny of Dæmonelix and the conditions attending the deposition of the beds in which the remains are found.

After some three or four weeks spent in the Dæmonelix beds, our attention was given to the underlying White River deposits. In these beds we were successful in securing a nearly complete skeleton of Titanotherium in splendid condition, besides many other animal remains of hardly less importance.

Of especial interest in connection with these deposits was the discovery in the Oreodon beds of a thin layer of limestone, from eight inches to a foot in thickness, containing in great abundance and in a beautiful state of preservation the remains of mollusca. Heretofore molluscan remains have been extremely rare in the White River, and have usually consisted of only imperfectly preserved casts. In a neighboring locality in the lower Titanotherium beds a fruit-bearing horizon was discovered in which were found the fossil fruits and silicified woods of the various trees and plants which grew in the Oligocene and Miocene forests of this region. From these fortunate discoveries we shall learn something of the invertebrate and plant life of this region in middle Tertiary times, and be the better able to form an intelligent idea of the physical conditions that prevailed here during the deposition of the clays, sandstones and limestones of the White River series.

In his work in this region the writer was very materially assisted by Mr. W. H. Utterback, and in all some ninety boxes of fossils have been packed by this party alone. Taken as a whole, the field work of the Department of Paleontology of the Carnegie Museum for the season of 1900 may be considered as successful, and the friends of the Museum have every reason to be grateful to its founder for the generosity shown in supplying the needed funds, without which the successful accomplishment of the work would have been impossible. The best thanks of the writer, under whose direction the work has been carried on, are due to Dr. W. J. Holland, the Director of the Museum, and to the President and members of the Museum Board for the very great interest they have shown in the work and their ever-ready aid in facilitating its accomplishment.

J. B. Hatcher.

OPENING OF THE ANTHROPOLOGICAL COLLECTIONS IN THE AMERICAN MUSEUM OF NATURAL HISTORY.

On October 30th the new anthropological collections in the American Museum of Natural History were opened to the public. While three years ago the anthropological material gathered in the Museum was installed in a single hall, its increase has been so rapid that at the present time the collections occupy five halls of the building, and two more halls are being arranged and will probably be opened in the near future.

The accessions to the anthropological collections of the Museum obtained during the last three years have largely been due to extended scientific research undertaken by the institution. In this respect the methods of the American Museum of Natural History differ considerably from those pursued by a number of other institutions. It has not been the policy of the Museum to accumulate rapidly and indiscriminately more or less valuable specimens collected on trading expeditions or purchased from dealers, but an endeavor has been made to build up representative collections, and to obtain at the same time the fullest and most detailed information in regard to specimens, so that each addition to the exhibit of the Museum can be made thoroughly instructive and will represent a material contribution to science.

In South America Dr. A. F. Bandelier carried on researches on the plateaus of Peru and Bolivia. Dr. Bandelier first went to South America for the Museum under the patronage of Mr. Henry Villard, while during later years the expenses of the expedition were borne by the Museum. The results of his work fill one of the new halls. Setting aside the beautiful fabrics, pottery, and other specimens, the collection abounds in skeletons and crania, which will be of great value in determining the physical characteristics of the ancient Peruvians.

Extensive archeological investigations have been carried on in Mexico. These were in charge of Mr. Marshall H. Saville. The work was liberally supported by the Museum and by the Duke of Loubat, to whose interest the Museum also owes a magnificent collection of reproductions of Central American sculptures. It is believed that in no other museum are the monumental works of the ancient inhabitants of Mexico and Central America so fully represented as in the American Museum of Natural History, where they fill an imposing hall. The Duke of Loubat also sent the renowned Americanist, Dr. Eduard Seler, to Mexico, the results of his labors being divided between the American Museum of Natural History and the Royal Ethnographical Museum of Berlin.

During the year 1898 the Museum employed Dr. Carl Lumholtz and Dr. A. Hrdlička in an ethnological investigation of the present tribes of the Sierra Madre Range, in western Mexico. While there Dr. Lumholtz continued his studies into the customs and religious beliefs of the Huichol Indians, which he had begun on a previous expedition undertaken for the Museum. Part of the results of his expedition have been published by the Museum, and the specimens which form the basis of this publication are now for the first time exhibited. Dr. Hrdlička studied the physical types of these people, but the specimens collected by him have not yet been arranged.

Another inquiry, carried on by officers of the Museum, has been directed towards an exploration of the ruins of the Southwest. This exploration has been undertaken at the expense and under the active supervision of Messrs. B. T. B. and F. E. Hyde, Jr., and has been carried on five years. The material collected includes the archeology as well as the physical anthropology of this area. The extensive series of specimens collected in the Southwestern ruins is at present being arranged, and will be opened to the public in the near future.

A thorough examination of the Trenton gravels with a view to discovering the geological distribution of remains of the early inhabitants of America has been continued during all these years. The means for this work have been provided by the Duke of Loubat for one year and by Dr. F. E. Hyde for the last three years.

Attention has also been paid to problems of local archeology, and a considerable amount of work has been done in exploring the Indian sites in the neighborhood of New York City.

Most important additions have been made to the collections illustrating the cultures of the people of the northern part of our continent. Most of these are due to the work of the Jesup North Pacific Expedition—a great undertaking, made possible by the munificence of Mr. Morris K. Jesup, President of the Museum. The collections obtained by this expedition up to the present time cover the region of the State of Washington, the coast of British Columbia, the interior of that province, Arctic Alaska, and southeastern Siberia, and large additional collections are expected from the Arctic coast of eastern Siberia. Some of the results of this expedition have been published in a large quarto volume, while a second volume is under way. The expedition promises to result in a thorough and exhaustive examination of both coasts of the North Pacific Ocean, and will settle the vexed question of the relations between the peoples of northeastern Asia and northwestern America.

The Museum has also been enabled to undertake work in the difficult field of Californian ethnology. The means of this work was provided by the late Mr. C. P. Huntington. Up to the present time attention has been paid particularly to an investigation of the tribes of central California, and valuable data regarding the distribution of human types and languages have been obtained, as well as an exceedingly interesting collection illustrating the culture of this region.

Farther to the north, work has been taken up in Oregon, where a number of almost unknown tribes exist which are fast disappearing. This work has been provided for by the liberality of Mr. Henry Villard, and has resulted in the acquisition of a beautiful collection from the tribes living near the boundary between Oregon and the State of Washington. In the course of this work, information has been secured on the customs and languages of the Alsea, a tribe which is on the verge of extinction.

The industries and arts of the Indians of the Great Plains have received their share of attention. The work of the Museum was directed particularly to an investigation of the Arapaho Indians. The funds for this inquiry were given by Mrs. Morris K. Jesup. The work has resulted in a most remarkable expansion of the North American collections of the Museum; and much information of great scientific value, largely referring to the specimens collected, has been obtained.

A favorable combination of circumstances has made it possible for the Museum to collect from several points of the Arctic coast of America interesting scientific data, illustrated by numerous specimens. In this way has been obtained an almost complete series of collections illustrating the life of the Eskimo, extending from Smith Sound in the east, to the west coast of Hudson Bay, and accompanied by notes on the customs and beliefs of the various tribes, which are in process of publication in the *Bulletin* of the Museum.

Besides these collections, which are due to systematic investigation, additional material has come into the possession of the Museum by gift and by purchase. Some of the important gifts of the Duke of Loubat, in connection with Central American and Mexican archeology, have already been mentioned. He also presented to the Museum reproductions of ancient Mexican codices, and archeological specimens from Guatemala and South America. The Museum received as a gift from Mr. J. Pierpont Morgan a beautiful collection of gold, silver and copper objects from Peru. Mr. W. Curtis James donated a collection from the Aino of Japan. Mr. Morris K. Jesup gave the means for a collection illustrating the domestic life of the Japanese. The Museum is indebted to Mr. James Douglas for an excellent collection of Apache basketry. Mr. Jacob Schiff gave to the Museum a collection illustrating the development of the iron industry among African negroes. A number of beautiful old pieces collected in the early part of our century among North American Indian tribes were given to the Museum, prominent among which is a donation made by Miss E. H. Cotheal.

A rather remarkable addition to the collections of the Anthropological Department was made by the transfer of the missionary exhibit arranged at the time of the 'Ecumenical Council' in April of this year. This collection gives an excellent start for the development of special exhibits illustrating the religions of primitive people. Among the purchases made by the Museum a large archeological collection from Illinois, the valuable Stahl connection from Porto Rico, the Gibbs collection from Turk's Island, and the Finsch collection from Melanesia, are worthy of special mention.

The new exhibits, just made accessible to the public, are proof of lively activity, and of a genuine interest taken by liberal patrons of science in the development of one of the most important scientific institutions of the City.

SCIENTIFIC BOOKS.

Grundlinien der anorganischen Chemie. By W. Ostwald. 14 x 22 cm., pp. xix + 795. Leipzig, Wilhelm Engelmann, 1900. Price, linen bound, 16; half leather, 18 marks.

The educational importance of this book is so great that it will not be amiss to paraphrase certain portions of the preface, the quotation marks referring to the ideas and not to the words.

"The object was to present the newer theories and their consequences at the beginning of the educational course so that the student should not be forced to master antiquated ways of looking at things, only to discard them later. While it was necessary in doing this to remodel the conventional type of text-book, as much as possible of the time-honored form of presentation has been kept. * * *

"One might perhaps teach chemistry as a deductive science, starting from a few general principles and introducing the properties of the different substances as illustrations of the general laws. This plan has not been followed, partly from an interest in the historical development and partly from a feeling that there were too many important details to make such a method satisfactory pedagogically. I have therefore kept the traditional arrangement according to elements and compounds, and have worked in the general laws as best I could. * * *

"Special pains have been taken with the development of the conception of ions. Sufficient attention has, perhaps, not been paid to the fact that it is possible and necessary to introduce this conception as a purely chemical and not as an electrical one. Although this idea was actually developed to explain the electrical phenomena, its importance in chemistry lies in its accounting for the chemical facts of reactions, characteristic of the constituents of salts. This is the point upon which stress has been laid. The electrolytic phenomena and Faraday's law serve, then, to widen and deepen the conception already deduced from the chemical phenomena."

The first three chapters form an introduction in which we find a brief but very lucid exposition of our fundamental concepts in regard to matter; a statement of the facts from which we deduce the laws of the conservation of mass and of energy; a discussion of combustion phenomena, with special reference to the changes of weight involved, and to the dissociation of mercuric oxide. The epistemological standpoint taken in the first chapter is very much more satisfactory than the materialistic one usually adopted. It is difficult to see any pedagogical advantage in postulating 'matter,' and it is certainly better, from a scientific point of view, to state what we know than to start with an assumption, however plausible. The besetting sin of most chemists is to substitute hypotheses and analogies for facts, and to believe that an analogy is an identity. The chemist is very ready to reason that, since Brown acts like Jones under certain circumstances, Brown must therefore be Jones.

In the fourth chapter, Ostwald gives a brief sketch of the different elements, and is then able to refer to any element at any time as a substance with which the student is already familiar. Probably every chemist has tried his hand at an arrangement of the subject which should require no use of, nor reference to, anything unknown, except the one point or substance under discussion. The difficulties in the way of such a task are enormous, and it is by no means certain that the problem can be solved without sacrificing other points of vastly more importance. The method followed by Ostwald, and before him by Bunsen, eliminates these difficulties and leaves one free to treat the subject in any desired way. It is a method to be defended along other lines. The student has a speaking acquaintance, at any rate, with zinc, iron, lead, mercury, silver, gold and other elements before he begins the study of chemistry. If this previous knowledge is not to be ignored, there is no reason why it should not be extended in an equally superficial way to include all the other elements.

The chemistry proper is divided into two parts, the non-metallic elements and the metals. Successive chapters are devoted to oxygen, hydrogen, water, hydrogen peroxide, chlorine, the oxygen compounds of chlorine, the remaining three halogens, sulphur and its compounds, selenium and tellurium, nitrogen, phosphorus, carbon, silicon, boron, and the gases argon, helium, etc. Under the metals, the order is: potassium, sodium, rubidium etc., calcium, magnesium, strontium etc., aluminum and the rare earths, iron, manganese, chromium, cobalt and nickel, zinc and cadmium, copper, lead, mercury, silver, tellurium, bismuth, antimony, arsenic, vanadium etc., tin and the allied metals, uranium etc., gold and the platinum metals. The book closes with a chapter on the choice of combining weights and on the periodic law.

The treatment is excellent throughout. In addition to the orthodox chemistry the student learns about many things which are ordinarily included in a special course on physical chemistry: rate of diffusion, reversible equilibrium, mass action, catalysis, phase rule, thermochemical relations, dissociation theory, electrolysis and Faraday's law, free energy, theorem of LeChatelier, strength of acids, relation of monotropic and enantiotropic forms, hydrolysis, reaction velocity.

The dissociation theory is introduced in a very natural way. It is first shown that the hydrogen of an acid differs from the hydrogen of other compounds in that it always shows the same reactions quite irrespective of the nature of the acid radical. Certain other properties are characteristic only of the hydroxyl of bases and are further independent of the basic radical. All soluble chlorides react with silver nitrate to form silver chloride. The radical whose reactions are independent of the other radical forming the salt is defined as an ion, and the characteristic properties of these ions are then discussed. It is then shown that salts are electrolytes, and that the ions of chemistry are also the ions of electrolysis.

There is no question but that this book is the official sign of the beginning of a new era in teaching introductory chemistry. Hitherto physical chemistry has been an independent branch of chemistry rather than the science of chemistry. While physical chemistry has exerted an influence upon elementary, analytic, inorganic, and organic chemistry, this has been an influence from without. An occasional fact has been worked into the frame here, an opening for a new view has been made there; but this has been a case of patching old garments in a vain attempt to keep them decently presentable. It is evident that the whole teaching of chemistry must be put on a new basis and carried on along scientific lines. This has been done for elementary chemistry in the book now under discussion, and it is now possible for those teaching introductory chemistry to present their subject in a satisfactory way, even though they may not themselves have been trained in physical chemistry.

The time is ripe for such a change. Ostwald has been working up to it for years. In this country, as well as in Europe, there are universities and colleges where lectures on elementary chemistry are now being given by physical chemists along similar, though not identical, lines. Holleman has recently published a text-book which may be looked upon as a forerunner of Ostwald's volume. While the reviewer is not so sanguine as to expect that Ostwald's book will be adopted at once throughout the length and breadth of the scientific world, yet the time is surely coming when the right way of teaching the subject will be the general way.

The fact that this book will revolutionize the whole teaching of introductory chemistry is a striking illustration of Ostwald's ability as an expounder. Ostwald has done much brilliant scientific work; but his real strength is as a teacher. It is not an exaggeration to say that the first edition of his *Lehrbuch* created the science of physical chemistry. Horstmann had had a glimpse of the promised land; but it was Ostwald who led the chemists into it. Van't Hoff originated the modern theory of solutions, Arrhenius the theory of electrolytic dissociation, and Nernst the osmotic theory of the voltaic cell; but it is Ostwald who has developed these theories and who has forced their acceptance. It is to Ostwald that we owe the rejuvenation of analytical chemistry and we now owe to Ostwald by far the best text-book on introductory chemistry.

Wilder D. Bancroft.

Twelfth Annual Report on the Railways of the United States, for the year ending June 30, 1899. By the Statistician to the Interstate Commerce Commission. Washington, Gov't Print. 1900. 8vo. Pp. 712.

It is unfortunate that some such system as is employed by the Census Bureau, adapted to this special line of work, cannot reduce the period of waiting for these reports. The Commission dates its report for the year ending June, 1899, precisely one year later than that date and the shortening of this delay and waiting would have value in high ratio with the proportion by which the period of delay might be reduced. Undoubtedly the Commission and its employees do their best, however, and we must hope for some later Hollerith to aid them in approximating coincidence of date of report with the close of the period reported upon. It is, nevertheless, a report worth waiting for. It gives us the mileage of all the railways of the country; a classification for the purposes of the report; data relating to equipment, number of men employed; capitalization and valuation of property, magnitude of the freight traffic, of the passenger movement, public service, earnings and expenses and profits, gross and net. A condensed summary follows and a general balance sheet. Railway accidents are discussed, recommendation made and a completely tabulated set of figures secured by the Commission is appended. It is a useful compendium to engineers, to railway men, to economists and to that rarer class, statesmen.

The total mileage, June 30, 1899, was 189,294.66 miles, a gain of 2,898.34 for the year. It is interesting to note that this increase has occurred mainly in the Southern States. The track mileage was 252,364.48, a gain of 4,831.96 miles, single track and sidings. This track is distributed among 2,049 railway corporations, of which about one-half are 'operating roads' and the balance leased lines or purchases, with 142 'private roads.' Of the total, 35 have been reorganized during the year, 20 have been consolidated and 42 merged in other lines, while 30 were abandoned, averaging, however, but 10 miles each. The larger systems are made up of a number of lines, each originally independent, and still holding, often, original charters.

Locomotives number 36,703, of which more than one fourth are passenger engines, one-half freight and the balance switching and special-service engines. Cars in service numbered 1,375,916, of which 33,850 were for passenger traffic and 46,556 assigned to the service of the company. Increasing economy of transportation is shown by a gain in density of traffic, both passenger and freight. Two-thirds of the trains were fitted with the train-brake, and nearly all with the automatic coupler, obviously an immense gain in safety over the conditions of but a few years since.

Employees numbered 928,924, or 495 per mile, a gain in two years of 105,448, with a *decrease* in number per mile of 20, indicating, again, gain in economy of operation. Their pay was $522,967,896, a gain of $27,912,278 for the employees' account during the year. This is 40 per cent. of the gross earnings and 60 per cent. of the operating expenses. "The fact indicates the extent to which wage-earners are interested in the conservative management of railways."

Capital aggregates $11,033,954,898, a gain of $215,400,867, more than twice that of the preceding year. Of the stock, $5,515,011,726, or 59.39 per cent., paid no dividends; but even this is better than the preceding year, in which 66.26 per cent. paid nothing. The funded debt, which passed its interest, amounted to $572,410,746, and was 10.45 per cent. of the total, a better statement than that of 1898, when 15.82 per cent. thus failed to meet its obligations.

Of the freight traffic, mines furnished 51.47 per cent.; manufactured products, next in order, 13.45; agriculture, 11.33; forestry, 10.89 — a distribution probably very surprising to many. The number of passengers carried one mile was 14,591,327,613, a gain of over 10 per cent.; the number of ton-miles of merchandise was 123,667,257,153, a gain of eight per cent. The gross earnings were $1,313,610,118; net, $482,090,923; net dividends, $94,992,909. Operating expenses aggregated $896,968,999, and practically an equal sum was distributed to employees and outside recipients as an addition to their incomes in form of wages, dividends, etc. The total surplus for the year was $53,064,877, to be compared with the *deficit* of the preceding year, $6,120,483.

Gross earnings were $7,005 per mile; operating costs, $4,570, and income $2,435. The revenue per unit was, per ton-mile, 0.734 cent; per passenger-mile it was 1.925, practically two cents. Per train-mile, the revenue was $1.01 for passengers and $1.79 for freight. Costs per train-mile are $0.9839.

Accidents remain a serious item, 7,123 people having been killed during the year and 44,620 injured, an increase for the year of four per cent. killed and over eight per cent. injured, notwithstanding the great increase in the use of automatic couplers, this being the dangerous point in railway operation. Of these totals, the passenger list of killed amounted to but 239, about three per cent., but employees constituted one-third the list. Of the injured, passengers were about eight per cent. only, the employees nearer 80 per cent. A passenger must travel, on the average, over 60,000,000 miles to lose his life; in New England, however, he must travel 125,290,750 miles; in the southwest he may lose it at the end of 34,327,-929 miles. The average traveler is hurt after traveling about 4,000,000 miles.

The report is a most important one, and should be carefully studied by all interested in any phase of the subject.

R. H. Thurston.

A Book of Whales. By F. E. Beddard. The Science Series. Published by G. P. Putnam's Sons, New York, and John Murray, London. 40 illustrations. 8vo. Pp. xv + 320.

The seventh publication of this well-known series is from the pen of the English editor, and attempts to gather into a comparatively small compass a general account of the Cetacea, and 'to illustrate by means of the group of whales a very important generalization, the intimate relation between structure and environment.'

In the absence of any other comprehensive work on the subject, the book will receive a hearty welcome. Teachers of anatomy and custodians of museums have long felt the need of some general work on the Cetacea, and there is a growing popular interest in all matters that relate to the life of the ocean. It is a pity, however, that the author did not make a good thing better by publishing a list of the more important papers bearing on his subject. American zoologists have contributed no small amount to the literature of the Cetacea, and Professor Beddard acknowledges the help he has received from the works of True, Cope and Scammon.

The introductory chapters make interesting reading. They deal with the external form and internal structure of whales, but assume that the reader has a general knowledge of the group and of comparative anatomy. The author himself is often not satisfied with the explanations that he gives for the existence of certain structures. It is indeed a hard matter to give plausible reasons for the existence of many devices of nature, and phylogenetic explanations based on hypothetical ancestors are not as convincing now as they were a few years ago.

The section on the stomach is especially interesting, and one is almost overcome when he reads of the amount of food that a hungry Cetacean can devour. The stomach of a 'bottle-nose' contained ten thousand beaks of squid, and a grampus contained thirteen porpoises and fourteen seals, all perfectly whole and intact. It is thought that large stones in the stomachs of certain whales may perform the same function that gravel performs in the bird's gizzard.

More than half the book deals with the various groups of Cetacea. The treatment is not technical, and the monotony of mere description is varied by anecdotes, historical reviews and what is now known as natural history.

The press work is of a high order, although the inversion of the figure of the right whale is evidence of some carelessness and gives the animal a most grotesque appearance. There are some other indications of lack of care in preparing copy and reading proof, but the general appearance of the book is good, and the text figures and many of the plates are excellent.

H. C. Bumpus.

GENERAL.

According to a plèbicite taken by the London *Academy* the 'Life and Letters of Huxley' is the most interesting book announced for publication this autumn. It is reported that in addition to this volume the letters exchanged between Huxley and Tyndall may be printed in full.

It is stated in the New York *Evening Post* that an interesting manuscript autobiography of the late Sir Richard Owen, the eminent paleontologist, has been discovered among a lot of old documents put up for sale in a London auction room. The existence of this manuscript was unknown and unsuspected, and it was only when the documents came into the hands of those familiar with the handwriting that its authorship was identified. A singular feature of the autobiography is that it is written, not in the first person, but chiefly in the third person, the author referring to himself as 'he' or to

'Richard Owen, a paleontologist of some repute.'

IT is stated that the bicentennial monographs to be written by Yale professors, publication of which will begin early next spring, will number not fewer than twenty-five. President Hadley and Professors Morris, Chittenden and Dr. T. T. Munger, of the Yale corporation, will have charge of the publications.

THE catalogue of the birds of New York State, undertaken by Dr. Marcus S. Farr, has made important progress and the first edition will probably be ready for publication within six months.

BOOKS RECEIVED.

The Laws of Gravitation. Memoirs by NEWTON, BOUGUER and CAVENDISH. Edited by A. STANLEY MACKENZIE. New York, Cincinnati and Chicago, The American Book Company. 1900. Pp. vii + 160.

The Effects of a Magnetic Field on Radiation. Memoirs by FARADAY, KERR and ZEEMAN. Edited by E. P. LEWIS. New York, Cincinnati and Chicago, The American Book Company. 1900. Pp. xviii + 102.

A Handbook of Photography in Colors. THOMAS BOLAS, ALEXANDER, A. K. TALLENT and EDGAR SENIOR. New York and Chicago. E. and H. T. Anthony & Co. London, Marion & Co. 1900. Pp. 230.

Studies of Animal Life. WALTER WHITNEY LUCAS. Boston, New York and Chicago. D. C. Heath & Co. 1900. Pp. 106.

Von Richter's Text-book of Inorganic Chemistry. Edited by H. KLINGER, translated by EDGAR F. SMITH. Fifth American Edition, Philadelphia. P. Blakiston's Son & Co. 1900. $1.75.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Journal of Science for November contains the following articles:

'Elaboration of the Fossil Cycads in the Yale Museum,' by L. F. Ward.

'Chemical Composition of Turquois,' by S. L. Penfield.

'Quartz Muscovite Rock from Belmont, Nevada; the equivalent of the Russian Beresite,' by J. E. Spurr.

'Volumetrio Estimation of Copper as the Oxalate, with Separation from Cadmium, Arsenic, Tin and Zinc,' by C. A. Peters.

'Synopsis of the Collections of Invertebrate Fossils made by the Princeton Expedition to Southern Patagonia,' by A. E. Ortmann.

'Cathode Stream and X-Light,' by W. Rollins.

IN the first report of the Michigan Academy of Science there is an abstract of a paper by Jacob Reighard on 'The Breeding Habits of the Dog-Fish, *Amia calva*,' showing that the nests are made by the male sometime before the spawning season by biting or tearing away aquatic plants, or other material on the bottom, leaving a concavity lined with roots, gravel or water-soaked plants. These nests may be quite near together or a considerable distance apart according to the numbers of fish and character of the bottom, and a single nest may be used by two fish in succession, consequently containing eggs in very different stages of development. The act of spawning occupies several hours, the eggs being deposited at considerable intervals.

The American Naturalist for October has for its leading article a 'Reconsideration of the Evidence for a Common Dinosaur-Avian Stem in the Permian,' concluding that this hypothesis should not be discarded, but very seriously kept in view. W. A. Cannon discusses 'The Gall of the Monterey Pine' and W. S. Nickerson has a 'Note on *Distomum arcanum* (n. sp.) in American Frogs' a species found so far only in frogs from Massachusetts. G. W. and E. G. Peckham have a brief article 'Instinct or Reason' noting a case in which one of the solitary wasps was led to depart from the customary manner of dragging insects into her burrow. The usual instalment of synopses of North American invertebrates is lacking. Editorial Comment, Reviews, etc., complete the number.

The Popular Science Monthly begins its fifty-eighth volume with the November number and has for its frontispiece a portrait of the late James Edward Keeler. The first article is an instalment of Professor Newcomb's 'Chapters on the Stars' and treats of binary and multiple stars, star clusters, nebulæ, and the methods by which they are investigated. Under 'Rapid Battleship Building' Waldon Fawcett notes the (comparatively) short time in which some of the very largest vessels have been constructed. The second part is given of 'The Address of the President (Sir William Turner) before the British Association for the Advancement of Science,' H. S. Pritchett discusses 'The Population of the United States during the Next Ten Centuries' computing that by 2900 it will amount to 41 billions, and Edward Atkinson has an article on 'The Distribution of Texas.' Clinton Rogers Woodruff considers in a hopeful vein 'Municipal Government now and a Hundred Years ago' and William Barclay Parsons has an article on 'China' giving a brief outline of its political and physical status. David Starr Jordan contributes a short skit on 'Rescue Work in History' and W. W. Campbell presents an appreciative sketch of James Edward Keeler. In 'Discussion and Correspondence' attention is called in an article that deserves to be read and heeded, to the literary sins of many writers on scientific topics. There are reviews of current scientific literature and notes of the progress of science.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 326th meeting was held on Saturday evening, October 20th, and was devoted to a 'Symposium on Cotton.'

H. J. Webber presented some 'Notes on Cotton Hybrids,' stating that the attempt was being made to produce a plant which should possess the long staple of the Sea Island Cotton, have a seed that would admit of the ready removal of the fiber and would grow well on the uplands. Hybrids he said were as a rule more vigorous than the parent plants, although being as regards structure and appearance intermediate between them. The speaker described some of the crosses that had been made and exhibited a series of specimens showing the successful results that had followed.

L. H. Dewey spoke concerning 'Some Foreign Varieties of Cotton,' saying that while the United States annually produces cotton to the value of nearly $400,000,000, it imports each year about $4,000,000 worth for special purposes. Most of our imported cottons, it was said, came from Egypt where they have been developed from Sea Island cotton, by long cultivation under irrigation, in a dry and practically rainless climate. The lint varies from snow white in 'Abbasi' to brown in 'Mitafifi.' The plants are large and spreading, similar to our Sea Island plants, but larger and with yellow flowers and small '3 locked' bolls. The lint is strong, lustrous, soft, and with a well developed twist. It is used chiefly for fine knit goods and for mercerized goods.

Peruvian cotton, which is borne on perennial cotton plants, has a short, brown, finely crimped fiber, and is imported for mixing with wool which it resembles.

A white uneven lint is produced in Porto Rico from a perennial plant, and plants of the 'kidney cotton' type are cultivated in the Philippines. In Paraguay the two principal varieties grown are red cotton (*Algodon colorado*), producing a reddish brown lint, and white cotton (*Algodon blanco*) producing white lint.

Nearly all varieties mentioned were illustrated by specimens, and leading American and Egyptian varieties were illustrated by full sized plants with flowers and mature bolls.

W. A. Orton read a paper on 'Selection for Resistance to the Wilt Disease of Cotton' a malady which has caused serious injury in the Sea Island Cotton and is becoming more troublesome in the upland cotton. It is caused by a soil parasite, *Neocosmospora vasinfecta* (Atk.) Erw. Sm., which attacks the young rootlets and grows from them into the vascular bundles of the main roots and of the stem, which are filled. The brown discoloration of the wood produced by the fungus is a characteristic symptom of the disease. Trials had been made of a large number of soil fungicides, but none had been found successful and the greatest hope of remedy seemed to lie in the production by selection of immune races of cotton.

A test of twenty kinds of cotton showed that the Egyptian sorts and one American upland variety, the Jackson, were strongly resistant to the wilt disease. These plants were somewhat dwarfed by the disease and there were numerous root tufts present, which demonstrated the presence of the fungus in the soil, and showed that the plants were actually resistant. Individual plants in diseased fields are often found living when all others around them have been killed, and seed from such plants has been saved with the intention of producing resistant races by selection and cross-breeding.

That the quality of resistance to the wilt disease is transmissible through the seed was proved by an experiment in which the seed of one such resistant plant of sea island cotton was planted beside an ordinary race. Every plant grown from the selected seed lived, while all the other cotton around it was killed. It is believed that a race of cotton entirely resistant to the wilt disease may be obtained by careful selection and cross-breeding.

L. M. Tolman discussed 'The Economic Uses of Cotton-Seed Oil' describing the methods of extracting and refining the oil of different grades, and noting the products of 2,000 pounds of seed. The rapid growth of the industry was described, as well as the various uses of the oil in salad oil, butterine, lard substitutes, etc., its value as food and digestibility as shown by recent experiments. Cotton-seed meal, a by-product in the manufacture of the oil was, the speaker said, valuable as a fertilizer and as food for cattle.

F. A. Lucas.

THE NEW YORK ACADEMY OF SCIENCES. SECTION OF BIOLOGY.

A meeting of the Section was held on October 8th, Professor C. L. Bristol presiding. The program offered consisted of reports of summer work by members of the section.

Professor E. B. Wilson reported that he spent the summer at Beaufort, N. C., where he prosecuted experimental researches upon the eggs of Toxopneustes. Loeb's experiments upon the eggs of Arbacia were confirmed, and further facts of great interest were determined. Later in the season Professor Wilson visited Woods Holl, Mt. Desert, Me., and the Bay of Fundy. He drew attention to the very great differences between the Beaufort and Bay of Fundy faunas. The transparent pelagic annelid Tomopteris was collected in the latter locality.

Dr. D. T. MacDougal spent the summer in studying the flora of Priest Lake, which stands at an elevation of 3,000 feet, in northern Idaho. He was especially concerned in studying the effect of air temperatures on the distribution of plants.

Professor H. F. Osborn visited the British Museum and the Museum of Comparative Anatomy in the Jardin des Plantes, Paris. The latter has, under the hand of Dr. Filhol, reached a high degree of effectiveness. At the British Museum Professor Osborn examined the remains of the new Patagonian sloth Neomylodon, the form said by Ameghino to be still extant.

Mr. F. B. Sumner gave an account of experiments carried on at the marine laboratory at Naples. The work of Mr. Sumner was directed towards determining the validity of his confluence theory of the origin of the embryo in fishes. The results are regarded as confirmatory.

The work in the Bermuda Islands, carried on in previous summers by the expeditions from the New York University under the direction of Professor Bristol, was continued this summer. Mr. F. C. Waite was this year a member of the party, and reported the finding of much valuable and interesting material not heretofore collected.

Dr. M. A. Howe also worked in the Bermudas during the first half of the summer, going later to Edgartown, Martha's Vineyard and to Sequin Island, Maine. He was especially concerned with the collection of marine algæ, of which he reported the acquisition of a large number. He described also the general floral features of the Bermudas.

Dr. H. E. Crampton stated that the summer session at Woods Holl has been a successful one.

Mr. M. A. Bigelow, while at Woods Holl, confirmed his results on *Lepas* and added a number of new observations. He, with Dr. Crampton, carried on a study of the ponds along the southern shore of Martha's Vineyard, with a view to studying the variation in their fauna.

Professor F. E. Lloyd spent six weeks in company with Professor S. M. Tracy in a preliminary study of the flora of the Mississippi Sound Islands and Delta. A full series of plants was collected. Professor Lloyd described the leading features of the vegetation of that region.

F. E. Lloyd,
Secretary.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the Section was held on October 22d. Reports of anthropological investigations made during the past summer were received from Dr. Franz Boas, Dr. Liv ingston Farrand, Dr. A. Hrdlicka, Dr. Putnam and Dr. R. E. Dodge. These investigations were made in the Vancouver Islands, Oregon, New Mexico, Arizona and California.

Charles H. Judd,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE EARLIEST USE OF THE NAMES SAURIA AND BATRACHIA.

To the Editor of Science: In glancing over my 'Address in Memory of Edward Drinker Cope,' published by the American Philosophical Society, I find I have inadvertently referred to 'Sauria and Serpentes' as 'Linnæan terms' instead of 'prior terms.' Serpentes only was used by Linnæus, that naturalist having confounded all his 'Amphibia' except the Serpentes under the group ('ordo') named 'Reptiles.' Brongniart first used the name 'Sauriens.' The slip would scarcely be of sufficient consequence to notice were it not that a question of nomenclature of some importance is involved on which I am enabled to throw some light.

Only the French form of the name—Sauriens—was used by Brongniart (1799) and it has been believed that Latreille (1804) or Duméril (1806) was the first to give a later equivalent. Meanwhile, however, Shaw (1802) used the name Lacertæ. There are many who hold that a vernacular name is insufficient and should be superseded by the first applicable Latin term. I do not share in that belief in respect to supergeneric groups (orders, etc.), but for the benefit of those who do, give the following facts.

Brongniart's name Sauriens was used very speedily after its proposal by Cuvier in his *Leçons d'anatomie comparée* in the 'troisième tableau' at the end of the first volume ('an VIII' = 1800), but there was no Latin equivalent. The Latin term Sauria was first introduced by Dr. James Macartney in a translation of the first volume of Cuvier's work published in 1802. This work must be quite rare, as the only copy I have been able to find is one I purchased at a second hand bookstore when a youth. Its full title is as follows: 'Lectures on Comparative Anatomy. | Translated from the French of | G. Cuvier, | Member of the National Institute, Professor in the College of France, and in the | Central School of the Pantheon, &c. | By William Ross; | under the inspection of | James Macartney, | Lecturer on Comparative Anatomy and Physiology in St. Bartholomew's Hospital, &c. | = | Vol. I | [etc.] | = | London, | printed at the Oriental Press, by Wilson and Co., | for T. N. Longman and O. Rees, Paternoster row. | — | 1802.

Macartney is responsible for the nomenclature. In his 'Preface,' (p. vi,) he remarks: "The names of the muscles [etc.] have been rendered into Latin" [etc.], and "the same mode has been adopted with respect to many of the terms in Natural History." He adds: "I have taken the liberty of correcting some errors in the original" [etc.], so there can be no doubt that to him is to be accredited the nomenclature adopted. His preface is dated 'London, March 18, 1802.'

All the ordinal names for reptiles are rendered into Latin in the third folded table at the end of the volume, viz.: Les Chéloniens by Chelonia; Les Sauriens by Sauria; Les Ophidiens by Ophidia, and Les Batraciens by Batrachia. 1802, then, is the date for those names, and not 1804, as stated by Dr. Baur in Science (N. S., VI., 172), who attributes their first Latinization to Latreille (1804). In this work also, it will be seen, is the first Latinization of Batraciens.

Dr. O. P. Hay (in Science, N. S., VI., 772) has advocated the retention of Batrachia instead of Amphibia, apparently because he thinks that "one thing is very certain, and that is that we cannot rigidly enforce, with respect to the appellatives of higher rank, the same rules that apply to genera. Common usage must and does determine much in the case of the former terms." If I accepted these ideas, I should still be in favor of retaining the name Amphibia in place of Batrachia. 'Common usage' among the Germans generally, as well as among many other zoologists, would warrant it. To me the name Batrachia, extended to cover all the class so designated, is very objectionable from a philological as well as historical point of view, and Amphibia is an excellent one.

Theo. Gill.

Washington, October 24, 1900.

NOTES ON INORGANIC CHEMISTRY.

AN account is given in the *Chemiker-Zeitung* of a dangerous accident occurring in the shipment of sodium peroxid. The material was destined for Japan and was in nine cases of sixty kilos each. It was contained in thin zinc boxes. In unloading, one of the first two cases exploded with a very loud report, a number of workmen were injured, several fatally, and a fire was caused. Serious consequences to the shipper may ensue, for the cases were merely labeled 'chemicals,' no evidence of the dangerous nature of their contents being furnished.

IN the manufacture of superphosphate for fertilizer, when apatite is used, large volumes of hydrofluoric acid are evolved, which contaminate the atmosphere very seriously, aside from being a commercial loss. A process has been devised by C. Elschner, which is described in the *Chemiker-Zeitung*, for the recovery and utilization of these gases in the form of fluorsilicic acid. This is used in the manufacture of artificial stone, and for hardening bath for both soft limestone and soft sandstone. A patent has also been issued for the utilization of fluorsilicic acid as a medium for preserving stable manure. The crude acid is absorbed by burnt and ground clay. This is dried again, pulverized and sprinkled upon the fresh manure in conjunction with a second powder consisting of either a mixture of sulfuric acid and kieselguhr or a ground bisulfate. It is claimed by the use of these powders all the valuable constituents of the manure are perfectly preserved.

A SERIES of articles on hydraulic cements by O. Rebuffat has appeared in the *Gazzetta*, from the laboratory of the School of Engineering at Naples. The natural puzzolana mortar is, when used under sea water, changed into a hydrated aluminum silicate containing little lime, and this silicate is very slightly influenced by the sea water. It seems to be much better to use the cement in the way generally used a few years ago that is, by grinding the puzzolana to an extremely fine powder rather than to mix it with sand. Artificial puzzolana can now rarely be made on terms which will enable it to compete with the natural product.

SOME time since Professor Fittica of Marburg announced that he had succeeded in transmuting phosphorus into arsenic. Professor Clemens Winkler seemed to be the only chemist who took Fittica's astounding claims seriously enough to refute them. Winkler showed that Fittica's results could indeed be obtained, but the arsenic was due, not to transmutation from phosphorus, but to impurity in the phosphorus. Fittica seems not to have availed himself of Winkler's offer of a specimen of phosphorus free from arsenic, with which to repeat his transmutation experiments. Now a rather extended paper by Fittica appears in the *Chemical News*, apparently translated from the *Chemiker Zeitung*, in which the author not only repeats his claim to have transmuted phosphorus into arsenic, but also claims, by varying the method, to obtain small quantities of antimony. He claims that Winkler's failure to obtain arsenic from pure phosphorus is due to his neglect to follow Fittica's method with exactness. A dozen years ago Fittica gave public utterance to the expression that at heart all chemists are still alchemists, in the sense of believing possible the transmutation of metals. Now he considers he has justified this expression.

A SERIES of experiments have been carried out by Alex. de Hemptinne for the purpose of determining whether in general an influence is exerted by magnetism on the equilibrium of a chemical reaction. These are described in the *Bulletin* of the Royal Belgian Academy. The reactions included the solution of iron in hydrochloric acid, the catalytic action of the hydrogen ion upon the saponification of methyl acetate and upon the inversion of sugar, and the union of hydrogen and chlorin. In all these cases the quantitative effect of a magnetic field was less than the probable error of experiment, so that it may be concluded that in these cases, at least, the influence of magnetism, if it exists at all, is very slight.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

MONTHLY WEATHER REVIEW.

THE *Monthly Weather Review* for August (dated October 16, 1900) contains a number of articles of more than ordinary interest. A report on 'Meteorological Observations during the Burning of the Plant of the Standard Oil Company at Bayonne, N. J., July 5, 6, and 7, 1900,' by W. H. Mitchell, notes the formation of cumulus clouds over the smoke from the fire, and the fact that the surface winds were drawn in towards the fire from a distance of over half a mile. The 'Climatology of St. Kitts, W. I.,' by W. H. Alexander, Observer Weather Bureau, discusses observations made in 1892–1899. Professor A. J. Henry considers 'The Hot Weather of August, 1900.' The initial movement which led to the hot wave during August was the slow drift of an area of high pressure southward and southwestward from southern New York, where it was located on August 4th, to the Ohio and Upper Mississippi valleys, in which region it culminated about the 8th. The warm weather extended from the Rocky Mountains to the Atlantic, and within this general area of high temperature there were small areas of excessive heating, as near St. Paul and St. Louis. At St. Paul the monthly mean temperature was 77.2 °, a higher average than has before been recorded there, and at St. Louis, also, the August mean was higher than any previously observed there. Two additional points are of special interest. From August 6th to August 11th, when the highest temperatures were recorded in Pennsylvania, Maryland, the District of Columbia and Virginia, the winds were from a northerly quarter. Secondly, between the 6th and the 11th the diurnal variation of the barometer at Washington was almost tropical in its regularity, and was very marked. Professor Abbe calls attention to the fact that a *Monthly Statement of Average Weather Conditions*, giving a brief discussion of the average weather conditions of each month as determined by long observation, is hereafter to be issued by our Weather Bureau. These statements are prepared in response to a popular demand for something in the way of a long range weather forecast. The first of these statements, that concerning August weather, is printed in this number of the *Monthly Weather Review*. Professor Abbe also has a paper on 'The Influence of the Lakes on the Temperature of the Land,' in which he concludes that "the direct influence of the lake water upon the temperature is appreciable for a few miles only ; the indirect influence, by reason of the formation of cloud and rain, may be felt for 50 miles."

CLIMATE OF CORDOBA (ARGENTINA).

Under the direction of Mr. Walter G. Davis, the Argentine Meteorological Office is issuing a series of reports on the climate of Argentina with a rapidity and to an extent which is certainly phenomenal. The latest volume, XIII., bearing the date 1900, embraces 620 pages, 33 of which concern the Annual Reports of the Director for 1894 and 1895, and the remainder of which (*i. e.*, 587 pages) consists of meteorological tables for Cordoba. These tables are a continuation of those published in Vol. IX., of the *Anales* of the Argentine Meteorological Office, which ended with the year 1893. The number of years included in the present volume is five, ending with 1898. The completeness of tabular presentation is admirable, there being, for example, twenty-six distinct tables giving the results of observations on evaporation alone. It is impossible to overestimate the value of the data contained in such reports as this.

R. DeC. Ward.

AN EXPLOSION OF SCIENTIFIC INTEREST.

A singular though not unprecedented accident took place at the Mammoth mine, in Utah, recently, illustrating applied thermodynamics in an interesting but fatal manner, causing the death of one and the severe injury of another of the engineers of the mine.

The cylinder of an air-compressor exploded while in operation in regular work, and with such violence as gave evidence of more than the action of the normal air-pressure in its production. The back cylinder-head and the cylinder itself were shattered; the violence of the explosion was terrific. The two men were thrown across the room and badly mangled and one instantly killed. Fragments of metal and of flesh were found outside the building and a long distance away. The air-pressure, at delivery from the compressor, was but 80 pounds per square inch. The cause of the explosion is presumed to have been the compression of the vapors of petroleum given off by oil used for lubrication in too large quantity and of too light a quality. Mingled with air in the right proportion for combustion, the mixture of air and vapor was heated by thermodynamic action of compression, approximately adiabatic up to the temperature of ignition, and the explosion followed. This action is precisely that relied upon in the Diesel gas-engine, recently attracting so much attention, for the ignition of its charge independently of gas-torch or electric spark. The phenomenon has long been known to the engineering profession, although instances of this kind of accident are rare. The use of effective methods of cooling the compressor-cylinder and the employment of lubricating oils of high flashing point constitute the preventives.

R. H. THURSTON.

SCIENTIFIC NOTES AND NEWS.

A BUST of the late Francis A. Walker is now being erected in the courtyard of the Boston Public Library, where it is planned to commemorate other eminent citizens of the city. The bust, which is in bronze, has been made by Mr. Richard E. Brooks, and the cost has been defrayed by an appropriation of $2,500 by the City Council.

THE London Society of Arts has awarded a silver medal to Professor R. W. Wood, of the University of Wisconsin, in recognition of his work on the diffraction process of color photography.

PROFESSOR MAX PETTENKOFER, of Munich, has been awarded the Pasteur medal of the Swedish Medical Association. This is the first award of the medal which is to be given every ten years for the most important work in hygiene and bacteriology.

DR. HERMAN S. DAVIS, recently expert computer of the U. S. Coast Survey, has been appointed observer at the International Latitude Observatory at Gaithersburg, Maryland, one of the six stations established by the Centralbureau der Internationalen Erdmessung for an investigation of variations of latitude.

LIEUT. C. LECOINTE has been appointed director of the astronomical work at the Brussels Observatory.

A LITTLE more than a year ago, says *Nature*, the attention of the Council of the Manchester Literary and Philosophical Society was directed to the fact that Dalton's tomb in Ardwick cemetery, Manchester, was in a very bad condition, owing to neglect. A committee was appointed to take steps to put the monument in a thorough state of repair, and there was no difficulty in obtaining subscriptions for this purpose. A full-page illustration of the tomb in its restored condition appears in the latest number of the *Memoirs and Proceedings* of the Society.

THE New York Board of Health is building, at a cost of $20,000, a laboratory to be wholly devoted to the study of the bubonic plague. It will be erected on the East River front on the grounds of the Willard Parker Memorial Hospital, and special care will be taken in its construction. The laboratory is to be of two-stories 25 x 50 feet. The ground floor will be occupied chiefly with eight stalls for horses that will supply the anti-plague serum. A staircase from the outside will lead to the upper floor, where experiments will be carried on. The walls and floor are of steel and cement, so as to be rat proof, and the windows are especially screened to keep out flies and mosquitoes.

During the recent visit of the *Albatross* to Japan considerable collections were made of the fauna of the coast within the 100-fathom line and on the edge of the Black Stream, the warm current which sweeps close to the eastern shores of the Japanese Islands. A number of rare and interesting species were takeu and the collections will be worked up by specialists in the several groups represented. The fishes have already been placed in the hands of President Jordan, of Leland Stanford Jr. University, together with specimens collected by the *Albatross* during a previous visit to Japanese waters. In addition to the Fish Commission collections, Dr. Jordan has in his possession the great collection made by him during the past summer and all the Japanese fishes of the United States National Museum, the Imperial University of Tokyo, the Imperial Museum of Japan and several minor collections.

THE great Serpent Mound of Ohio, which has long been a subject of study and research for American archeologists, has been given by the

Harvard Corporation to the Ohio State Archeological and Historical Society. The mound has been in the possession of the Peabody Museum since 1886, when it was purchased by private subscriptions amounting to $6,000, chiefly from citizens of Boston. The understanding was that the Museum should take charge of the mound until some local society should be able to receive it. Of late years there has been difficulty in taking care of the Serpent Mound Park, and it has therefore been transferred to the Ohio society.

THE appropriation of $20,000, made by the New York Legislature of this year for repairs and improvements in Geological Hall of the State Museum, is now being expended in the installation of a steam heating plant and various repairs aud new features which will greatly aid the work of the museum and permit the concentration of the departments of the State botanist and the State entomologist in the same building with the department of geology.

PLANS are being formulated for an entomological exhibit, in connection with other divisions of the New York State Museum, at the Pan American Exposition. A small synoptic collection, representing many of the more important economic insects causing trouble in the house, field or forest, together with examples and illustrations of their operations, and a collection showing something of the history and work of the office, will be some of the principal features of the exhibit.

A MUSEUM of commerce has recently been established at Bangkok under the direction of the Japanese Government, which pays all the running expenses except the salary of the director. It is proposed to exhibit in the museum samples of all the commercial products of Japan.

PRESIDENT CLAUSEN, of the New York City Park Department, asked the Board of Estimate some time ago for a bond issue of $3,000,000, the proceeds to be used in building the New York Public Library at Fifth Avenue and Forty-second street. The application was referred to Comptroller Coler, and his engineer, Mr. Eugene McLean, has reported practically approving the proposed plans. He estimates that a bond issue of $2,850,000 will cover the cost. Of this amount Mr. McLean estimates that $2,700,000 will be needed for construction, $108,000 for architects' fees and $27,000 for engineers' salaries and other incidentals. In removing the old reservoir $500,000 has already been expended.

BESIDES small collections received in exchange from other museums, the Peabody Museum has recently received some important additions to its general collection. Among them is a set of fossils and of Indian relics obtained by Professor Beecher during his trip to Arizona last summer. Professor Brewer and Dr. Coe, who went with the Harriman expedition to Alaska in the summer of 1899, have presented to the Museum two painted Alaskan totem poles, one representing a bear, the other a kingfisher with extended wings. Professor Penfield has given the Museum some interesting calcite crystals obtained by him near Cayuga Lake, New York. The Egyptian collection, derived from the Egyptian exploration fund and secured at Abydos, is on its way to the Museum. It consists mainly of implements, pottery and ornaments, some of them of gold.

THE American Section of the Free Museum of Science and Art of the University of Pennsylvania has received an important collection of ethnological objects from many North American tribes, the result of an expedition undertaken last summer by the curator, Mr. Culin. The expedition was fitted out at the expense of the Hon. John Wanamaker. Mr. Culin accompanied Dr. George A. Dorsey of the Field Columbian Museum who planned the trip. Sixteen tribes were visited scattered from Iowa to British Columbia, and the collections illustrate the life of the North American Indian in many phases. The objects obtained from the Pacific coast tribes are particularly valuable. Even more important collections were made by Dr. Dorsey for the Field Columbian Museum.

THE U. S. Fish Commission steamer *Albatross* has now returned to San Francisco after a fourteen months' cruise in the South Seas and in Japanese and Alaska waters. Mr. Alexander Agassiz's account of some of the scientific results of the voyage has already been published in this

Journal, but it appears that in addition the steamship, under Commander J. F. Moser, has secured important data for charts and maps.

IT is stated in *Nature* that Mr. J. S. Budgett, of Trinity College, Cambridge, who, it will be remembered, accompanied Mr. Graham Kerr on his journey in search of *Lepidosiren*, and who last year spent several months investigating the zoology of the Gambia region, has just returned to England from a second expedition to that river. Mr. Budgett's main object was to obtain material for studying the development of the Crossopterygian fish *Polypterus*. In his first expedition he obtained eggs and larvæ which were said to be those of this fish, but which, as it turned out, belonged apparently to a Teleost. Mr. Budgett has in his recent expedition failed to obtain the *Polypterus* material, but he is to a certain extent compensated for this by having obtained a mass of embryological material which appears to be of great interest. Amongst this is a practically complete series of eggs and larvæ of the Dipnoan *Protopterus* whose developmental history had hitherto remained quite unknown. The developmental stages of all three surviving members of the important group Dipnoi—*Ceratodus*, *Lepidosiren* and *Protopterus*, belonging to Queensland, South America and Africa respectively—owe their discovery and first observation to workers of the Cambridge school of zoology.

IN connection with the United States Geological Survey, the Yale School of Forestry is to undertake on an extensive scale the measurement of the flow of some of the larger streams of Connecticut. The first station has already been established at Merwinsville on the Housatonic River.

PROFESSOR DAVID P. TODD, of Amherst College, in a lecture in Brooklyn, on November 1st, exhibited biograph pictures of the solar corona taken at the recent eclipse. About 300 pictures were taken in a period of one minute and twenty seconds, and these were reproduced on the screen at the same rate.

THE survey of the crystalline rocks of the Adirondack region and of the Highlands area of southeastern New York has recently made rapid progress, and the results are now available for the new edition of the large geologic map of the State, which will go to press before the close of this year. Important work has been done in quaternary geology by Dr. J. B. Woodworth, of Harvard University, and Professor H. L. Fairchild, of the University of Rochester.

THE National Geographic Society has decided to discontinuet be technical course of lectures during November and December and to omit the Lenten course this season. The course of popular lectures will be opened Friday, November 9, 1900, by Mr. M. H. Saville, of the American Museum of Natural History, New York, the subject being 'The Ancient City of Mitla, Mexico.' The second lecture will be given by General A. W. Greely, Chief Signal Officer, U. S. A., on Friday evening, November 23, 1900. General Greely's subject will be 'A Trip through Alaska.'

THE course of free public lectures for the winter season at the University of Pennsylvania has been announced. The lectures will be delivered in the College Chapel on Tuesday afternoons at four o'clock. Those in science are as follows: March 19, 1901, Lightner Witmer, 'Mind and Body'; March 26, 1901, John M. Macfarlane, 'The Adaptation of Plants to their Surroundings'; April 2, 1901, Arthur W. Goodspeed, 'Color'; April 9, 1901, Edwin G. Conklin, 'Some Recent Advances in our Knowledge of Life'; April 16, 1901, Alexander C. Abbott, 'The Management of Polluted Water Supplies and its Influences upon Public Health.'

ACCORDING to the daily papers officers of the German Government have arranged with the Principal of the Tuskegee Normal and Industrial Institute to send three graduates of that institution to the German colony on the west coast of Africa for the purpose of introducing the raising of cotton among the natives. Two of the graduates are from the agricultural department and one from the mechanical department. The latter will construct gin-houses, etc. Mr. J. N. Calloway, one of the instructors of Tuskegee, accompanies the party to assist in the inauguration of the work.

The German Government pays the men a liberal salary as well as all travelling expenses. The party sails from New York, November 3d, and takes from Tuskegee a full outfit for cotton-raising, including cotton-seed, ploughs, cotton gins, and wagons and carpentry tools.

WE are requested to state that the second part of the 'List of Private Libraries' compiled by Mr. G. Hedeler, of Leipzig, will soon be ready. It will contain more than 600 important private collections of the United Kingdom, including a supplement to Part I. (United States and Canada). Those possessors of libraries, with whom Mr. Hedeler has been unable to communicate, are requested to furnish him with details as to the extent and character of their libraries if they contain more than 3,000 volumes or have a special character. By doing so, they will, of course, not incur any expense or obligation.

UNIVERSITY AND EDUCATIONAL NEWS.

RUSH MEDICAL COLLEGE, Chicago, is to have a new building costing $80,000, for which Dr. Nicholas Senn has just given $50,000. It will be principally used for administrative purposes and will be named Senn Hall.

THE will of Frank Williams, late of Johnstown, makes a bequest of $300,000 to Lehigh University, for the benefit of worthy students. The income is to be loaned to students who are unable to pay their way through college. Their notes are to be taken for the amount borrowed, and the money, when returned, is again to be placed in the fund.

AMHERST COLLEGE receives $10,000 by the will of the late Edward N. Gibbs.

AMONG the bequests in the will of John Sherman are $5,000 to Oberlin College and $5,000 to Kenyon College.

IT is the purpose of the friends of the late William L. Wilson and of the alumni of Washington and Lee University, of which he was president, to raise by subscription a fund of at least $100,000 to maintain a professorship in the University, to be known as the Wilson enendowment.

MRS. JANE K. SATHER, of Oakland, California, has given $10,000 to the University of California, the income to be used in the purchase of books for the library. This is in addition to her recent gift of $100,000, the income from which she is to receive during her life.

THE Harvard Medical School has outgrown its present building and the land on which it stands will sometime be needed for the Boston Public Library. An estate has been bought in Brookline to which it is proposed at some future time to remove the Medical School as well as the allied schools of veterinary medicine and dentistry.

IT is proposed to build at Chicago University a group of buildings for the social functions of the University. The group includes a dining hall, assembly hall and a club-house for male students. It is hoped that the $400,000 needed for the buildings will be subscribed by next spring when building operations will be commenced.

THE total income of the colleges of agriculture and mechanical arts supported wholly or in part by the Government was for the year 1898–99 $6,193,016; 35,458 students were registered.

THE total registration at the University of Michigan to date is 3,648, divided as follows: literary, 1,537; law, 840; medicine, 520; engineering, 345; dentistry, 268; homœopathy, 71; pharmacy, 67. The total registration last year was 3,441, of whom 167 matriculated after the end of October.

MR. HUGO DIEMER has been elected assistant professor of mechanical engineering at the Michigan State Agricultural College.

PROFESSOR JOHN CRAIG has been appointed extension professor of agriculture and horticulture in the Agricultural College of Cornell University.

AT Cambridge, Dr. G. E. Rogers, of Gonville and Caius, has been appointed demonstrator in anatomy; Mr. C. T. R. Wilson, M.A., of Sidney Sussex College, has been appointed demonstrator in experimental physics and Mr. J. S. E. Townsend, B.A., fellow of Trinity College, has been appointed assistant demonstrator in physics.

SCIENCE

FRIDAY, NOVEMBER 16, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ADMINISTRATION OF GOVERNMENT SCIENTIFIC WORK.

A CORRESPONDENT, whose letter is printed in another column, calls attention to the oft-recurring questions of the superintendency and organization of the U. S. Coast and Geodetic Survey. Whatever may be the merits or demerits of the considerations adduced by this correspondent with reference to matters of detail, it is evident that the essentials of these questions are quite as important now as they have been at any time during the past half-century. These essentials are, in fact, not limited in their application to any one scientific bureau of the government, but are of equal importance to all of them. The question of reorganization of the Naval Observatory is now pending, after a long and painstaking investigation by a committee specially delegated to consider the matter; and the question of the establishment of a new bureau which may take charge of the indispensable business of national standards is likely to come up in the near future. The mode of selection of a head, or director, of any one of these scientific bureaus is, then, or at least ought to be, a matter of concern to all men of science; for whatever mode is applied in any case is likely to serve as a precedent for the next.

It goes without saying that the method of selection of such heads is, in our country, an unsatisfatcory one. Not that this method always secures incompetent appointees; many eminent men have come thus into the government service in spite of the method; but it presents an open door to the formidable class of opportunists whose claims to high office are not based on professional qualifications. Thus, not infrequently, notoriously unfit men are placed temporarily in charge of the highest grades of scientific work. Their ridiculous careers in such rôles are generally short, but yet long enough to establish precedents which place-hunters of all sorts are not slow to utilize. Hence it follows that the tenure of office of the heads of our scientific bureaus is short; that the conduct of bureau work is usually less effective than it ought to be; and that the employees in such bureaus are periodically distracted with the fear that at the next turn of the kaleidoscope they may find themselves officially decapitated. It is a fact, we believe, that the superintendents of the Coast and Geodetic Survey have succeeded one another during several decades with a rapidity only surpassed by that of recent political events in China. One may well marvel how, under such adverse conditions, it has been possible for this bureau to accomplish so much first-class scientific work as is actually recorded in its bulky annual reports.

But the practical enquiry in this connection is, 'what are we going to do about it?' How long is it going to be possible, for example, for mere 'influence,' often prepared in the most shameless manner, to stampede the President of the United States into appointing to professorships of mathematics in the navy men who know nothing of that science, or into appointing to the superintendency of the Coast and Geodetic Survey men who may convert that bureau into a manufactory of ten-place logarithms?

Our correspondent suggests, we think, a practicable way out of the difficulty. It does seem proper, as he urges, that the scientific organizations of our country should interest themselves in matters which, according as they are well or ill administered, must reflect credit or discredit on American science. Why may not the National Academy of Sciences become in fact, as it is by law entitled to be, the adviser of the government in matters scientific? Or, if it is for any reason impracticable for this Academy to fulfill its natural functions, why may we not have a board of regents, similar to that of the Smithsonian Institution, whose duty it shall be to give the government advice concerning the direction of national scientific work? There is no reason, apaarently, why we may not have such an advisory body unless it be the inadequate reason of 'general apathy.' Our government could, if it would, and our scientific organizations can, if they are willing to make the effort, secure just such expert advice as is needed free of cost. We venture to assert, for example, that if either the National Academy of Sciences or the American Society of Civil Engineers were asked to do so it would speedily suggest two or three eminently worthy candidates for the position of superintendent of the Coast and Geodetic Survey or for the directorship of the proposed bureau of standards. Moreover, it is believed that either of these societies would be willing to cite in the public prints reasons for the fitness of such candidates based on lists of their published works and on histories of their professional careers. It is doubtful, of course, whether an eminently fit person would, under existing circumstances, accept such a position; but the establishment of a high standard of appointment would help more than any thing else to make the position worthy of an able man and to make his tenure of office reasonably secure.

Has not the time arrived when the scientific societies of the country should unite in an effort to raise the standard of qualifications for a directorship of government scientific work? We believe the time has come; and we believe also that Congress would welcome the advice of a representative committee of scientific men of the country on all questions relating to the work and administration of our scientific bureaus.

It may be said, however, that experience has revealed well-nigh insuperable difficulties in the way of the needed changes. One must confess, in fact, that the reforms of the democratic and republican administrations of the Coast and Geodetic Survey during the past twenty years have corrected only minor evils; and that the efforts of the past thirty years to get the Naval Observatory on an astronomical rather than on a naval footing have proved almost fruitless. But depressing as this experience is, it ought not to suppress the optimism of patriotic men of science. It ought rather to lead them to renewed studies of these perennial questions, especially since the prosecution of scientific work is apparently coming to be more and more a part of the business of civilized nations the world over. Possibly the reformers have failed hitherto because they have sought to accomplish too much, or because they have sought to accomplish the wrong things. The problems presented are evidently very complex, and their solution may be unattainable except by the method of successive approximation. Perhaps we should be content as a first step to secure the necessary legislation for the creation of a board of advisers with reference to appointments to prominent positions in the scientific bureaus. It is hardly conceivable that such a board would, if composed of well-known men, ever propose any one conspicuously unfit for official position. Once establish the custom of choosing only men of good scientific repute to direct scientific work, and there would be little danger of relapse to the present haphazard system. In short, the plane of reference for appointments to national posts of honor and trust in science needs to be raised at least to the level of that which is applied in the case of appointments to justiceships in the Supreme Court. When the office seeks the man, and when the office is worthy of the untiring devotion essential to eminence in science, our government will secure officers of whom we need not feel ashamed, and the petty annoyances of which our correspondent complains, in a measure justly, no doubt, will disappear without special attention.

*A DETERMINATION OF THE NATURE AND VELOCITY OF GRAVITATION.**

The present note is to be taken as a supplement to my previous paper on 'The Nature of the Electric and Magnetic Quantities.'† A fuller development of the theory of gravitation advanced by the writer is in course of preparation. This will, however, be delayed for some time, possibly for several years, as it is desired to investigate certain phenomena rather more accurately than has hitherto been done, and at present the writer is occupied with pressing work in another line.

It has seemed advisable, however, to publish this determination of the velocity of gravitation at the present time, and without waiting to complete the fuller treatment, for the reason that, as will be seen later, the value obtained clears up a number of perplexing optical problems, and removes a number of obstacles which have hitherto stood in the way of the development of that branch of physics.

On account of the fact that the writer's papers on these subjects have unavoidably been published in somewhat scattered form, it is considered best to give a brief résumé of the work which forms the basis of the method by which this velocity is deduced.

In 1893 the writer perceived that Fourier's 'Dimensions' could be developed into a very powerful agent of research, and one which should bear a relation to the usual methods similar to that which Qualitative chemistry bears to Quantitative. It was for this reason that the name 'Qualitative Mathematics' was given to this new branch.

As its name signifies, it is used, not for the exact determination of numerical quantities, but for the prediction and classification of phenomena.*

It was first shown † that the nature of electricity and magnetism was, at that time, indeterminate, as all the electric and magnetic phenomena which we were able to completely express dynamically could be comprised in three qualitative equations, whilst we had four unknown quantities.

Then, by several methods, Williams's result, that either specific inductive capacity, (k), or permeability (μ), must be a density, the other term being a compliancy, was confirmed.

It was then further deduced that the one which is a compliancy must decrease with the first power, whilst the one which is a density must decrease with the second power, of the corresponding intensities, *i. e.*, if F be the electric potential difference per unit length, and H be the magnetic potential difference per unit length, then if μ be

* Being a supplement to 'A Determination of the Nature of the Electric and Magnetic Quantities and of the Density and Elasticity of the Ether.'

† *Phys. Rev.*, January, 1900; and also of the earlier papers: 1891–2, on 'The Laws and Nature of Cohesion.'

* Such a branch of mathematics is absolutely necessary to supplement the work done by the other methods. For the latter can tell us nothing of the *nature* of the quantity involved. Their very greatest strength is their greatest weakness. The fact that a certain function, which gives us the state of things at the end of an organ pipe, also gives us the way a current of electricity distributes itself near the end of a wire dipping in a mercury cup is gratifying in its comprehensiveness, but disappointing in that when we meet that function, we do not know which of the many possible phenomena it represents. Take, for instance, our equations for light. They fit in with a simple elastic-solid wave, and we have fallen into the habit of speaking of light as really being such a wave, and some eminent physicists, even, as I have pointed out elsewhere, have fallen into the mistake of supposing that the magnetic rotation of light necessarily implies a rotation of the medium in a magnetic field, overlooking the fact that the whole proof is based on this unfounded, and, as we now know, certainly incorrect, supposition. All that the equations really mean is that light is some kind of periodic motion, but, if I remember rightly (as it was some years ago that I investigated the matter), there are eight kinds of periodic motion which can be equally well represented by the light equations.

† *Ibid.*, also *Elect. World*, May 18, 1895.

a compliancy, on increasing H, μ will decrease by an amount depending upon the first power of H, and on increasing F, k will decrease by an amount depending upon the second power of F. Also, in this latter case, the diminution of k must depend inversely upon the coefficient of volume elasticity.

On the other hand, if it is k which is the compliancy, these relations will be interchanged.

It was at once noticed that several of the empirical formulæ expressing the relation between H and μ gave a diminution depending upon the first power of H. A somewhat elaborate investigation was then undertaken, extending over the greater part of a year, and the fact was definitely established that the diminution did depend upon the first power of H accurately, the maximum amount of deviation from that called for being less than one-fourth of one per cent., which was about the limit of experimental accuracy.

This, of itself, would have sufficed to have settled the point, but in addition the other relation, which should exist if the theory were correct, *i. e.*, that the specific inductive capacity, k, should vary with the inverse second power of the slope of electric potential, and as the coefficient of volume elasticity, was also discovered. This was found to be the complete expression of Kerr's electrostatic phenomenon.

A prism of glass, one cm. thick and one cm. wide, stretched with a force of 30.10^6 dynes gave a change of density of nearly 3.10^{-5}. The change in the thickness of the glass was approximately $1.5.10^{-5}$. The change in velocity of the light which passed transversely through the glass, was approximately $.7 \times 10^{-5}$.

It was thus found that the actual mechanically produced change in density of the glass was sufficient to account for the observed change of velocity, though the agreement was not so close as it might have been, possibly owing to experimental difficulties.

From the observed change in velocity when placed in a strong electrostatic field, whose value was approximately determined by its sparkling distance, it was calculated that the value of the $F^2/8\pi k$ stress required to produce the same change of velocity as had been produced mechanically was nearly 25.10^6 dynes. The value of the purely mechanically applied stress, as given above, was 30.10^6. The close agreement is probably accidental, as the experimental error was considerably greater than the small difference observed. It is intended to repeat these experiments under conditions permitting of a much higher degree of accuracy.

The results obtained are however sufficient to show that Kerr's effect can be accounted for by purely mechanical stresses, electrically produced and resulting in a change of density.

Now it was pointed out above, that whichever of the medium coefficients, k or μ, varies as the square of the corresponding intensity, that one must be a density. Since, therefore, it has already been shown by Kerr that the change in velocity, and hence, as my experiments prove, the change in density,* is proportional to the square of the electric intensity, it follows that k is a density.

It still remained to be shown that Kerr's effect depended upon the volume elasticity. This was done by testing different glasses and noting that, the compensating pieces being made from the glass under test, the same force was always required to compensate, independent of the material tested.

We see, therefore, that the results deduced from the experiments on the relation between H and μ are completely confirmed

* Velocity is proportional to square root of density, but change of velocity is proportional to change in density, both being small.

by the results obtained on investigating the relations between F and k.

A number of additional pieces of corroborative evidence were also given, *i. e.*:

3. The relation between the magnetic constant a and the elasticity.

4. The relation between this constant and elastic strain.

5. The relation between this constant and permanent strain.

6. The relation between this constant and hysteresis.

7. The relation between k and the density of substances.

Several phenomena were also predicted, *i. e.*:

A. A change in the velocity of light, along a slope of electric potential.

B. A relation between refractive index and piezo-electric effect in doubly refracting substances.

These have not yet been confirmed, but arrangements are being made to investigate the former.

This same result, originally obtained by qualitative mathematics, can also be obtained by Lagrangian methods. By considering the way in which permeability and specific inductive capacity are affected in the case of stressed iron, and in the case of Kerr's phenomenon, as influenced by the elasticity of the material, it can be shown that a change in μ involves the first power of the magnetic intensity and that a change of k involves the second power of the electric intensity. This proof will be given later. It, however, in reality, adds nothing to the proof already given, which in the opinion of the writer is of such a character that we may say that the nature of electricity and magnetism is now definitely and finally determined, though no doubt it may be years before the absolutely decisive nature of the proof is generally appreciated.

Next, it follows from the writer's experiments on the relation between H and μ that the presence of matter does not alter the elasticity of the ether by as much as one-fourth of one per cent. Also, knowing now that k is a density, we are enabled to say that aberrational and other optical phenomena show that the density of the ether is not appreciably altered by the presence of matter, otherwise the $(n^2 - 1)$ and similar formulæ would not hold. From these facts we see that the actual volume of the atom, compared with the space occupied by it, must be quite small.

The diameter of the mercury atom I have shown to be $2.75\ (\pm 0.2) \times 10^{-8}$, and in 1899 I showed that the actual cross section of the space actually occupied by the atom must be less than one four-hundredth of the space occupied by the atom to the exclusion of other atoms, and that the atoms 'must have a configuration analogous, in its effects, to that of structures of thin platinum wire, suspended in oil.'

Later, J. J. Thomson, from his beautiful and wonderfully ingenious work on electric discharges in gases, was able to show that the atom is made up of a number of smaller bodies, which he calls corpuscles.

On comparing the results of Thomson, Ewers, Kaufmann, Lenard, Lorenz, Wiechert and Simon, we arrive at the conclusion that there are about 1,000 corpuscles in a hydrogen atom, and that the weight of a corpuscle is therefore about 1.5×10^{-27} gm.

Since, then, there are about 200,000 corpuscles in a mercury atom, and their cross section is less than one four-hundredth part of the cross section of the mercury atom, we find that the diameter of the corpuscle is certainly less than 2.10^{-11} cm.

From J. J. Thomson's formula for the electrically produced inertia of a charged sphere, we find, as was shown by Thomson (and independently by the writer), that if the diameter of the corpuscle is approximately 10^{-13} cms., the ionic charge which it carries will account for its full quantity of inertia.

So long as we knew nothing of the size of the corpuscle, and since there might be a thousand corpuscles in a hydrogen atom, and yet each corpuscle be about 3.10^{-9} cms. in diameter, we were hardly justified in holding that inertia is an electric phenomenon. But when we take into consideration, in addition, the writer's proof that the diameter of the corpuscle must be less than $\frac{1}{1000}$ the diameter of the atom, and that this is the *superior* limit in size, we have a reasonable basis for holding, as the writer has done,* that the corpuscular charges are the cause of the inertia of matter.

Assuming this, we arrive at the result that the corpuscle is about $\frac{4}{3} \times 10^{-13}$ cms. in diameter. The ionic equivalent being about $4 (\pm 1) \times 10^{-10}$ e. s. units, we find for the electrostatic tension and pressure at the surface of the corpuscle, about 2.10^{32} dynes.

One of the theorems immediately deducible by Qualitative Mathematics is that, "Whenever the electric or magnetic forces act in the presence of matter, the resultant effect is made up of two terms, one expressing the result of the action on the matter, the other that of the action on the ether."

We have seen that the electric stresses produce a change of volume in matter, and hence we must have also an effect of the same quality in the ether. Such a change of density in the ether would produce a gravitational attraction, and we may now calculate what value the ether constants must have in order to produce the observed amount of gravity which is associated with the corpuscle.

Taking Boys's value for the gravitational attraction of two masses, each of one gramme, and one cm. apart, *i. e.*, 6.65×10^{-8}, we get for the gravitational energy of the corpuscle about 10^{-48} ergs.

* *Elect. World*, May, 1900.

From this and the electrostatic stress we can calculate the volume elasticity, and we find it to be about 10^{73}.

But I have previously shown that the density of the ether is about 0.66 and its rigidity about 6.10^{20}.

Hence we can calculate the value of the compressional or gravitational wave, and find it to be approximately 5.10^{36} cms. per second.

It will be at once seen that this value agrees with our astronomical facts, and that it does away with a great many optical difficulties. For in the first place it makes the compressional wave vanish, and in addition, which is of the greatest importance, it makes the amount of energy in the compressional wave infinitesimally small.*

We may summarize our conclusions as follows:

The ether itself is a composite body, having a structure whose elastic properties are analogous to rubber. This is shown by the low value of the rigidity as compared with the compressibility, and by the form of the equation expressing the relation between H and μ.

This would immediately suggest a vortex theory, even if the quality of the ionic charge, *i. e.*, M/T, were not called to the attention. If we take Fitzgerald's vortex theory, and develop it along the lines indicated by my theory we have the vortices analogous to what, in the case of india rubber, I have called the 'skein material,' and the fluid in which the vortices form, which,

* In a paper on Comet's Tails, *Astrophysical Review*, January, 1897, the writer showed that all the phenomena so far noted in this connection, including the bridge of Biela's comet, the apparent retardation, the shape, etc., could be accounted for by supposing that the ultra-violet light of the sun acted on the surface of the nucleus of the comet to throw off negatively charged particles. It is possible that this compressive wave may be a factor in this discharge, though on the other hand it is possible that the light itself may be sufficiently effective.

until some one suggests a better name, we will call etherōn, taking the place of the 'filling-in material.'* The compressibility of the etherōn is very high, as we have seen, it being the thing which determines the velocity of the compressive wave. The vortex structure is what is concerned in transmitting the light waves and its modulus; the rigidity modulus is much smaller and of a different order, just as in the case of india rubber.

We do not need more than one vortex, 'the umbilical cord of the universe,' as one aspect of it suggested itself, stretching with its ends fixed on some free surface of the etherōn and itself forming one inextricable tangle. The circulation being the same everywhere simplifies matters. The parting of the vortex anywhere means the destruction of all matter.

Such a medium, as Fitzgerald has shown, gives an ether which can transmit light. Following up this theory, we conclude that corpuscles are vortex singularities, and that it is the hydrodynamic head of their flow which gives the etherōn density-variation round them. This change in density varies as the fourth power of the distance from the corpuscle. All the gravitational energy tends to that of compression, and if two corpuscles come together, their gravitational energy goes to increasing the compression energy of the ether. They do not come together because their approach brings into play forces which depend upon the energy of the vortices themselves. The fact that there is but one vortex, and consequently the circulation is the same everywhere, gives the atoms definite sizes and the corpuscles the same quantity of electricity, *i. e.*, the ionic charge.

A group of so many thousands of these corpuscles makes up the atom. The inertia of the atom is due to the electromagnetic inductance of the corpuscular charge, and gravity is due to the change of density of the ether surrounding the corpuscles, produced by the electrostatic stress of the corpuscular charge. Mass and gravity thus bear a constant ratio.

* Ether is the structure formed by the fluid and the vortices, etherōn the fluid alone.

The cohesive force of the atoms, as I have shown elsewhere,* is due to the electrostatic attraction of the atoms for one another. Chemical force, as has been shown by Davy, Berzelius, Helmholtz, Ostwald and other workers, is due to the same cause.

It may here be noted that the idea of the ionic charge as an ever-present element of the atom is an interesting example of a theory, negatived absolutely, apparently, by fundamental principles, and yet developing in spite of its apparent incompatibility with facts in many other directions, with such success as to finally obtain a firm footing, although the arguments against it have never been answered.

The fact that the ionic charge is the agent in chemical action had been shown by the physicists just mentioned above. The presence of charged ions in electrolytes had also been firmly established, and J. J. Thomson had suggested that conduction in metals also took place through a breaking up of molecular groups, as in the case of electrolytes. But when in 1890 and 1891 † I introduced the theory that the ionic charge is attached to the atom, *not only when it is concerned in chemical actions or formed part of a molecule, but in every case and always*, and is the cause of a number of physical phenomena, such as cohesion, rigidity, etc., a number of objections were made; that charges could not exist in the interior of a conductor; that the atoms of metals must be conducting, and so could not have equal charges of electricity; and others, as for example, the well founded

* *Elect. Soc.*, Newark, 1890; *Elect. World*, Aug. 8–22, 1891.

† *Ibid.*

criticism of Ostwald (under date Sept. 16, 1891): "The electrostatic theory of cohesion is new to me, * * * but for electrolytes there is the question to be answered, why stuffs like alcohol, etc., do not conduct? whilst according to *your* theory, *all* elements have electric charges."

These objections could not be met then, and have not been met up to the present time, in spite of the fact that this new concept (of the ionic charge being a fundamental part of the atom, apart from its chemical functions) has proved a most fertile one, and has been considerably developed by the originator and by later workers, Richartz, Chattock, Lorentz, Larmor and others. Nor will these objections ever be met until we know the nature of metallic conduction.

This is one of the great outstanding problems. It has long been known that there is a relation between electric and heat conductivity. The writer has shown that there is a connection between the velocity of sound (and hence the elasticity and density) and the electric conductivity of wires. J. J. Thomson, as mentioned above, suggested that the current was carried by the electrolysis of molecular groupings, and his later work renders it probable that it is by means of the corpuscles. It is possible that the atoms of a metal are really dissociated and the negatively charged corpuscles are in a state similar to that of the ions of a solution, *i. e.*, the metallic atom is not a fixed combination of certain corpuscles, but is constantly changing in composition, the negative corpuscles being, as it were, in solution in the metal, and changing about freely.

Such an hypothesis would account for the relation between the velocity of sound and the electric conductivity. For the cohesion of the atoms would be due to these negative corpuscles acting, as the mortar between bricks, to bind together the positive groupings, and hence the greater the number of free corpuscles the greater the elasticity and the greater the conductivity, the conductivity being simply the number of free corpuscles per cubic centimeter. The greater the number of corpuscles in the positive groupings, *i. e.*, the greater the molecular mass, the less the conductivity.

In presenting this summary I am aware, of course, that much of it is in need of further experimental evidence, and I hope, in time, to supply at least a part of this. It is considered, however, that the scheme here presented has a weight apart from its experimental foundation, in that it is a whole and consistent theory by which for the first time all physical phenomena are reduced to the simplest possible elements.

REGINALD A. FESSENDEN.

ADDRESS OF THE PRESIDENT OF THE SECTION OF GEOLOGY OF THE BRITISH ASSOCIATION.

I.

EVOLUTIONAL GEOLOGY.

THE close of one century, the dawn of another, may naturally suggest some brief retrospective glance over the path along which our science has advanced, and some general survey of its present position from which we may gather hope of its future progress; but other connection with geology the beginnings and endings of centuries have none. The great periods of movement have hitherto begun, as it were, in the early twilight hours, long before the dawn. Thus the first step forward, since which there has been no retreat, was taken by Steno in the year 1669; more than a century elapsed before James Hutton (1785) gave fresh energy and better direction to the faltering steps of the young science; while it was less than a century later (1863) when Lord Kelvin brought to its aid the powers of the higher mathematics and instructed it in the teachings of modern physics. From Steno onward the spirit of geology was catastrophic; from Hutton onward it grew increasingly uniformitarian; from the time of Darwin and Kelvin it has become evolutional. The ambiguity of the word 'uniformitarian' has led to a good deal of fruitless logomachy, against which it may be as well at once to guard by indicating the sense in which it is used here. In one way we are all uniformitarians, *i. e.*, we accept the doctrine of the 'uniform action of natural causes,' but, as applied to geology, uniformity means more than this. Defined in the briefest fashion it is the geology of Lyell. Hutton had given us a 'Theory of the Earth,' in its main outlines still faithful and true; and this Lyell spent his life in illustrating and advocating; but as so commonly happens the zeal of the disciple outran the wisdom of the master, and mere opinions were insisted on as necessary dogma. What did it matter if Hutton as a result of his inquiries into terrestrial history had declared that he found no vestige of a beginning, no prospect of an end? It would have been marvellous if he had! Consider that when Hutton's 'Theory' was published William Smith's famous discovery had not been made, and that nothing was then known of the orderly succession of forms of life, which it is one of the triumphs of geology to have revealed; consider, too, the existing state of physics at the time, and that the modern theories of energy had still to be formulated; consider also that spectroscopy had not yet lent its aid to astronomy and the consequent ignorance of the nature of nebulæ; and then, if you will, cast a stone at Hutton. With Lyell, however, the case was different: in pressing his uniformitarian creed upon geology he omitted to take into account the great advances made by its sister sciences, although he had knowledge of them, and thus sinned against the light. In the last edition of the famous 'Principles' we read: "It is a favorite dogma of some physicists that not only the earth, but the sun itself, is continually losing a portion of its heat, and that as there is no known source by which it can be restored we can foresee the time when all life will cease to exist on this planet, and on the other hand we can look back to a period when the heat was so intense as to be incompatible with the existence of any organic beings such as are known to us in the living or fossil world. * * * A geologist in search of some renovating power by which the amount of heat may be made to continue unimpaired for millions of years, past and future, in the solid parts of the earth * * * has been compared by an eminent physicist to one who dreams he can discover a source of perpetual motion and invent a clock with a self-winding apparatus. *But why should we despair of detecting proofs of such generating and self-sustaining power in the works of a Divine Artificer?*" Here we catch the true spirit of uniformity; it admittedly regards the universe as a self-winding clock, and barely conceals a conviction that the clock was warranted to keep true Greenwich time. The law of the dissipation of energy is not a dogma, but a doctrine drawn from observation, while the uniformity of Lyell is in no sense an induction; it is a dogma in the narrowest sense of the word, unproved, incapable of proof, hence perhaps its power upon the human mind; hence also the transitoriness of that power. Again, it is only by restricting its inquiries to the stratified rocks of our planet that the dogma of uniformity can be maintained with any pretence of argument. Directly we begin to search the heavens the possibility, nay even the likelihood, of the nebular origin of our system, with all that it involves, is borne in upon us. Lyell therefore consistently refused to extend his gaze beyond the rocks beneath his feet, and was thus lead to do a serious injury to our science; he severed it from cosmogony, for which he entertained and expressed the most profound contempt, and from the mutilation thus inflicted geology is only at length making a slow and painful recovery. Why do I dwell on these facts? To depreciate Lyell? By no means. No one is more conscious than I of the noble service which Lyell rendered to our cause; his reputation is of too robust a kind to suffer from my unskilful handling, and the fame of his solid contributions to science will endure long after these controversies are forgotten. The echoes of the combat are already dying away, and uniformitarians, in the sense already defined, are now no more; indeed, were I to attempt to exhibit any distinguished living geologist as a still surviving supporter of the narrow Lyellian creed, he would probably feel, if such a one there be, that I was unfairly singling him out for unmerited obloquy.

Our science has become evolutional, and in the transformation has grown more comprehensive; her petty parochial days are done, she is drawing her provinces closer around her, and is fusing them together into a united and single commonwealth—the science of the earth.

Not merely the earth's crust, but the whole of earth-knowledge is the subject of our research. To know all that can be known about our planet, this, and nothing less than this, is its aim and scope. From the morphological side geology inquires, not only into the existing form and structure of the earth, but also into the series of successive morphological states through which it has passed in a long and changeful development. Our science inquires also into the distribution of the earth in time and space; on the physiological side it studies the movements and activities of our planet; and not content with all this it extends its researches into etiology and endeavors to arrive at a science of causation. In these pursuits geology calls all the other sciences to her aid. In our commonwealth there are no outlanders; if an eminent physicist enter our territory we do not begin at once to prepare for war, because the very fact of his undertaking a geological inquiry of itself confers upon him all the duties and privileges of citizenship. A physicist studying geology is by definition a geologist. Our only regret is, not that physicists occasionally invade our borders, but that they do not visit us oftener and make closer acquaintance with us.

EARLY HISTORY OF THE EARTH: FIRST CRITICAL PERIOD.

If I am bold enough to assert that cosmogony is no longer alien to geology, I may proceed further, and taking advantage of my temerity pass on to speak of things once not permitted to us. I propose, therefore, to offer some short account of the early stages in the history of the earth. Into its nebular origin we need not inquire—that is a subject for astronomers. We are content to accept the infant earth from their hands as a molten globe ready made, its birth from a gaseous nebula duly certified. If we ask, as a matter of curiosity, what was the origin of the nebula, I fear even astronomers cannot tell us. There is an hypothesis which refers it to the clashing of meteorites, but in the form in which this is usually presented it does not help us much. Such meteorites as have been observed to penetrate our atmosphere and to fall on to the surface of the earth prove on examination to have had an eventful history of their own of which not the least important chapter was a passage through a molten state; they would thus appear to be the products rather than the progenitors of a nebula.

We commence our history, then, with a rapidly-rotating molten planet, not impossibly already solidified about the center and surrounded by an atmosphere of great depth, the larger part of which was contributed by the water of our present oceans, then existing in a state of gas. This atmosphere, which exerted a pressure of something like 5,000 pounds to the square inch, must have played a very important part in the evolution of our planet. The molten exterior absorbed it to an extent which depended on the pressure, and which may some day be learnt from experiment. Under the influence of the rapid rotation of the earth the atmosphere would be much deeper in equatorial than polar regions, so that in the latter the loss of heat by radiation would be in excess. This might of itself lead to convectional currents in the molten ocean. The effect on the atmosphere is very difficult to trace, but it is obvious that if a high-pressure area originated over some cooler region of the ocean, the winds blowing out of it would drive before them the cooler superficial layers of molten material, and as these were replaced by hotter lava streaming from below, the tendency would be to convert the high into a low-pressure area, and to reverse the direction of the winds. Conversely under a low-pressure area the in-blowing winds would drive in the cooler superficial layers of molten matter that had been swept away from the anticyclones. If the difference in pressure under the cyclonic and anticyclonic areas were considerable, some of the gas absorbed under the anticyclones might escape beneath the cyclones, and in a later stage of cooling might give rise to vast floating islands of scoria. Such islands might be the first foreshadowings of the future continents. Whatever the ultimate effect of the reaction of the winds on the currents of the molten ocean, it is probable that some kind of circulation was set up in the latter. The universal molten ocean was by no means homogeneous: it was constantly undergoing changes in composition as it reacted chemically with the internal metallic nucleus; its currents would streak the different portions out in directions which in the northern hemisphere would run from northeast to southwest, and thus the differences which distinguish particular petrological regions of our planet may have commenced their existence at a very early stage. Is it possible that as our knowledge extends we shall be able by a study of the distribution of igneous rocks and minerals to draw some conclusions as to the direction of these hypothetical lava currents? Our planet was profoundly disturbed by tides, produced by the sun; for as yet there was no moon; and it has been suggested that one of its tidal waves rose to a height so great as to sever its connection with the earth and to fly off as the infant moon. This event may be regarded as making the first critical period, or catastrophe if we please, in the history of our planet. The career of our satellite, after its escape from the earth, is not known till it attained a distance of nine terrestrial radii; after this its progress can be clearly followed. At the eventful time of parturition the earth was rotating, with a period of from two to four hours, about an axis inclined at some 11° or 12° to the ecliptic. The time which has elapsed since the moon occupied a position nine terrestial radii distant from the earth is at least fifty-six to fifty-seven millions of years, but may have been much more. Professor Darwin's story of the moon is certainly one of the most beautiful contributions ever made by astronomy to geology, and we shall all concur with him when he says, "A theory reposing on *veræ causæ*, which brings into quantitative correlation the length of the present day and month, the obliquity of the ecliptic, and the inclination and eccentricity of the lunar orbit, must, I think, have strong claims to acceptance."

The majority of geologists have long

hankered after a metallic nucleus for the earth, composed chiefly, by analogy with meteories, of iron. Lord Kelvin has admitted the probable existence of some such nucleus, and lately Professor Wiechert has furnished us with arguments—'powerful' arguments Professor Darwin terms them—in support of its existence. The interior of the earth for four-fifths of the radius is composed, according to Professor Wiechert, chiefly of metallic iron, with a density of 8.2; the outer envelope, one-fifth of the radius, or about 400 miles in thickness, consists of silicates, such as we are familiar with in igneous rocks and meteorites, and possesses a density of 3.2. It was from this outer envelop when molten that the moon was trundled off, twenty-seven miles in depth going to its formation. The density of this material, as we have just seen, is supposed to be 3.2; the density of the moon is 3.39, a close approximation, such difference as exists being completely explicable by the comparatively low temperature of the moon.

The outer envelope of the earth which was drawn off to form the moon was, as we have seen, charged with steam and other gases under a pressure of 5,000 lb. to the square inch; but as the satellite wandered away from the parent planet this pressure continuously diminished. Under these circumstances the moon would become as explosive as a charged bomb, steam would burst forth from numberless volcanoes, and while the face of the moon might thus have acquired its existing features, the ejected material might possibly have been shot so far away from its origin as to have acquired an independent orbit. If so we may ask whether it may not be possible that the meteorites, which sometimes descend upon our planet, are but portions of its own envelope returning to it. The facts that the average specific gravity of those meteorites which have been seen to fall is not much above 3.2, and that they have passed through a stage of fusion, are consistent with this suggestion.

SECOND CRITICAL PERIOD. 'CONSISTENTIOR STATUS.'

The solidification of the earth probably became completed soon after the birth of the moon. The temperature of its surface at the time of consolidation was about 1,170° C., and it was therefore still surrounded by its primitive deep atmosphere of steam and other gases. This was the second critical period in the history of the earth, the stage of the 'consistentior status,' the date of which Lord Kelvin would rather know than that of the Norman Conquest, though he thinks it lies between twenty and forty millions of years ago, probably nearer twenty than forty.

Now that the crust was solid there was less reason why movements of the atmosphere should be unsteady, and definite regions of high and low pressure might have been established. Under the high-pressure areas the surface of the crust would be depressed; correspondingly under the low-pressure areas it would be raised; and thus from the first the surface of the solid earth might be dimpled and embossed.*

THIRD CRITICAL PERIOD. ORIGIN OF THE OCEANS.

The cooling of the earth would continuously progress, till the temperature of the surface fell to 370° C., when that part of the atmosphere which consisted of steam would begin to liquefy; then the dimples on the surface would soon become filled with superheated water, and the pools so formed would expand and deepen, till they formed the oceans. This is the third crit-

*It would be difficult to discuss with sufficient brevity the probable distribution of these inequalities, but it may be pointed out that the moon is possibly responsible, and that in more ways than one, for much of the existing geographical asymmetry.

ical stage in the history of the earth, dating according to Professor Joly, from between eighty and ninety millions of years ago. With the growth of the oceans the distinction between land and sea arose—in what precise manner we may proceed to inquire. If we revert to the period of the 'consistentior status,' when the earth had just solidified, we shall find, according to Lord Kelvin, that the temperature continuously increased from the surface, where it was 1,170° C., down to a depth of twenty-five miles, where it was about 1,430° C., or 260° C. above the fusion point of the matter, forming a crust. That the crust at this depth was not molten but solid is to be explained by the very great pressure to which it was subjected—just so much pressure, indeed, as was required to counteract the influence of the additional 260° C. Thus if we could have reduced the pressure on the crust we should have caused it to liquefy; by restoring the pressure it would resolidify. By the time the earth's surface had cooled down to 370° C. the depth beneath the surface at which the pressure just kept the crust solid would have sunk some slight distance inwards, but not sufficiently to affect our argument.

The average pressure of the primitive atmosphere upon the crust can readily be calculated by supposing the water of the existing oceans to be uniformly distributed over the earth's surface, and then by a simple piece of arithmetic determining its depth; this is found to be 1.718 miles, the average depth of the oceans being taken at 2.393 miles. Thus the average pressure over the earth's surface, immediately before the formation of the oceans, was equivalent to that of a column of water 1.718 miles high on each square inch. Supposing that at its origin the oceans were all 'gathered together into one place,' and 'the dry land appeared,' then the pressure over the ocean floor would be increased from 1.718 miles to 2.393 miles, while that over those portions of the crust that now formed the land would be diminished by 1.718 miles. This difference in pressure would tend to exaggerate those faint depressions which had arisen under the primitive anti-cyclonic areas, and if the just solidified material of the earth's crust were set into a state of flow, it might move from under the ocean into the bulgings which were rising to form the land, until static equilibrium were established. Under these circumstances the pressure of the ocean would be just able to maintain a column of rock 0.886 miles in height, or ten twenty-sevenths of its own depth. It could do no more; but in order that the dry land may appear some cause must be found competent either to lower the ocean bed the remaining seventeen twenty-sevenths of its full depth, or to raise the continental bulgings to the same extent. Such a cause may, I think, be discovered in a further effect of the reduction in pressure over the continental areas. Previous to the condensation of the ocean, these, as we have seen, were subjected to an atmospheric pressure equal to that of a column of water 1.718 miles in height. This pressure was contributory to that which caused the outer twenty-five miles of the earth's crust to become solid; it furnished, indeed, just about one-fortieth of that pressure, or enough to raise the fusion point 6° C. What, then, might be expected to happen when the continental area was relieved of this load? Plainly a liquefaction and corresponding expansion of the underlying rock.

But we will not go so far as to assert that actual liquefaction would result; all we require for our explanation is a great expansion; and this would probably follow whether the crust were liquefied or not. For there is good reason to suppose that when matter at a temperature above its ordinary fusion point is compelled into the solid state by pressure, its volume is very responsive to changes either of pressure or temperature. The remarkable expansion of liquid carbon dioxide is a case in point: 120 volumes of this fluid at — 20° C. becomes 150 volumes at 33° C.; a temperature just below the critical point. A great change of volume also occurs when the material of igneous rocks passes from the crystalline stage to that of glass; in the case of diabase* the difference in volume of the rock in the two states at ordinary temperature is 13 per cent. If the relief of pressure over the site of continents were accompanied by volume changes at all approaching this, the additional elevation of seventeen twenty-sevenths required to raise the land to the sea-level would be accounted for.† How far down beneath the surface the unloading of the continents would be felt it is difficult to say, though the problem is probably not beyond the reach of mathematical analysis; if it affected an outer envelope twenty-five miles in thickness, a linear expansion of four per cent. would suffice to explain the origin of ocean basins. If now we refer to the dilatation determined by Carl Barus for rise in temperature in the case of diabase, we find that between 1093° and 1112° C. the increase in volume is 3.3 per cent. As a further factor in deepening the ocean basins may be included the compressive effect of the increase in load over the ocean floor; this increase is equal to the pressure of a column of water 0.675 mile in height, and its effect in raising the fusion point would be 2° C., from which we may gain some kind of idea of the amount of compression it might produce on the yielding interior of the crust. To admit that these views are speculative will be to confess nothing; but they certainly account for a good deal. They not only give us ocean basins, but basins of the kind we want, that is, to use a crude comparison once made by the late Dr. Carpenter, basins of a tea-tray form, having a somewhat flat floor and steeply sloping sides; they also help to explain how it is that the value of gravity is greater over the ocean than over the land.

The ocean when first formed would consist of highly heated water, and this, as is well known, is an energetic chemical reagent when brought into contact with sili-

*C. Barus so names the material on which he experimented; apparently the rock is a fresh dolorite without olivine.

† Professor Fitzgerald has been kind enough to express part of the preceding explanation in a more precise manner for me. He writes: "It would require a very nice adjustment of temperatures and pressures to work out in the simple way you state it; but what is really involved is that in a certain state diabase (and everything that changes state with a considerable change of volume) has an enormous isothermal compressibility. Although this is very enormous in the case of bodies which melt suddenly, like ice, it would also involve very great compressibilities in the case of bodies even which melted gradually, if they did so at all quickly, *i. e.*, within a small range of temperature. What you postulate, then, is that at a certain depth diabase is soft enough to be squeezed from under the oceans, and that, being near its melting point, the small relief of pressure is accompanied by an enormous increase in volume which helped to raise the continents. Now that I have written the thing out in my own way it seems very likely. It is, anyway, a suggestion quite worthy of serious consideration, and a process that in some places must almost certainly have been in operation, and may be is still operative. Looking at it again, I hardly think it is quite likely that there is or could be much squeezing sideways of liquid or other viscous material from under one place to another, because the elastic yielding of the inside of the earth would be much quicker than any flow of this kind. This would only modify your theory, because the diabase that expands so much on the relief of pressure might be that already under the land, and raising up this latter, partly by being pushed up itself by the elastic relief of the inside of the earth and partly by its own enormous expansibility near its melting point. The action would be quite slow, because it would cool itself so much by its expansion that it would have to be warmed up from below, or by tidal earth-squeezing, or by chemical action, before it could expand isothermally.

cates like those which formed the primitive crust. As a result of its action saline solutions and chemical deposits would be formed; the latter, however, would probably be of no great thickness, for the time occupied by the ocean in cooling to a temperature not far removed from the present would probably be included within a few hundreds of years.

THE STRATIFIED SERIES.

The course of events now becomes somewhat obscure, but sooner or later the familiar processes of denudation and the deposition started into activity, and have continued acting uninterruptedly ever since. The total maximum thickness of the sedimentary deposits, so far as I can discover, appears to amount to no less than 50 miles, made up as follows:

Recent and Pleistocene	4,000	Man.
Pliocene	5,000	Pithecanthropus.
Miocene	9,000	
Oligocene	12,000	
Eocene	12,000	Entheria.
Cretaceous	14,000	
Jurassic	8,000	
Trias	13,000	Mammals.
Permian	12,000	Reptiles.
Carboniferous	24,000	Amphibia.
Devonian	22,000	Fish.
Silurian	15,000	
Ordovician	17,000	
Cambrian	16,000	Invertebrata.
Keeweenawan	50,000	
Penokee	14,000	
Huronian	18,000	

Geologists, impressed with the tardy pace at which sediments appear to be accumulating at the present day, could not contemplate this colossal pile of strata without feeling that it spoke of an almost inconceivably long lapse of time. They were led to compare its duration with the distances which intervene between the heavenly bodies; but while some chose the distance of the nearest fixed star as their unit, others were content to measure the years in terms of miles from the sun.

EVOLUTION OF ORGANISMS.

The stratified rocks were eloquent of time, and not to the geologist alone; they appealed with equal force to the biologist. Accepting Darwin's explanation of the origin of species, the present rate at which form flows to form seemed so slow as almost to amount to immutability. How vast then must have been the period during which by slow degrees and innumerable stages the protozoon was transformed into the man! And if we turn to the stratified column, what do we find? Man, it is true, at the summit, the oldest fossiliferous rocks 34 miles lower down, and the fossils they contain already representing most of the great classes of the Invertebrata, including Crustacea and Worms. Thus the evolution of the Vertebrata alone is known to have occupied a period represented by a thickness of 34 miles of sediment. How much greater, then, must have been the interval required for the elaboration of the whole organic world! The human mind, dwelling on such considerations as these, seems at times to have been affected by a sur-excitation of the imagination, and a consequent paralysis of the understanding, which led to a refusal to measure geological time by years at all, or to reckon by anything less than 'eternities.'

GEOLOGIC PERIODS OF TIME.

After the admirable address of your President last year it might be thought needless for me to again enter into a consideration of this subject; it has been said, however, that the question of geological time is like the Djin in Arabian tales, and will irrepressibly come up again for discussion, however often it is disposed of. For my part I do not regard the question so despondingly, but rather hope that by persevering effort we may succeed in discovering the talisman by which we may compel the unwilling Djin into our service. How immeasurable would be the advance of our science could we but bring the chief events which it records into some relation with a standard of time!

Before proceeding to the discussion of estimates of time drawn from a study of stratified rocks let us first consider those which have been already suggested by other data. These are as follows: (1) Time which has elapsed since the separation of the earth and moon, fifty-six millions of years, minimum estimate by Professor G. H. Darwin. (2) Since the 'consistentior status,' twenty to forty millions (Lord Kelvin). (3) Since the condensation of the oceans, eighty to ninety millions, maximum estimate by Professor J. Joly.

It may be at once observed that these estimates, although independent, are all of the same order of magnitude, and so far confirmatory of each other. Nor are they opposed to conclusions drawn from a study of stratified rocks; thus Sir Archibald Geikie, in his address to this Section last year, affirmed that, so far as these were concerned, one hundred millions of years might suffice for their formation. There is then very little to quarrel about, and our task is reduced to an attempt, by a little stretching and a little paring, to bring these various estimates into closer harmony.

Professor Darwin's estimate is admittedly a minimum; the actual time, as he himself expressly states, 'may have been much longer.' Lord Kelvin's estimate, which he would make nearer twenty than forty millions, is founded on the assumption that since the period of the 'consistentior status' the earth has cooled simply as a solid body, the transference of heat from within outwards having been accomplished solely by conduction.*

It may be at once admitted that there is a large amount of truth in this assumption; there can be no possible doubt that the earth reacts towards forces applied for a short time as a solid body. Under the influence of the tides it behaves as though it possessed a rigidity approaching that of steel, and under sudden blows, such as those which give rise to earthquakes, with twice this rigidity, as Professor Milne informs me. Astronomical considerations lead to the conclusion that its effective rigidity has not varied greatly for a long period of past time.

Still, while fully recognizing these facts, the geologist knows—we all know—that the crust of the earth is not altogether solid. The existence of volcanoes by itself suggests the contrary, and although the total amount of fluid material which is brought up from the interior to the exterior of the earth by volcanic action may be, and certainly is, small—from data given by Professor Penck, I estimate it as equivalent to a layer of rock uniformly distributed 2 mm. thick per century; yet we have every reason to believe that volcanoes are but the superficial manifestation of far greater bodies of molten material which lie concealed beneath the ground. Even the wide areas of plutonic rock, which are sometimes exposed to view over a country that has suffered long-continued denudation, are merely the upper portion of more extensive masses which lie remote from view. The existence of molten material within the earth's crust naturally awakens a suspicion that the process of cooling has not been wholly by conduction, but also to some slight extent by convection, and to a still greater extent by the bodily migration of liquid lava from the deeper layers of the crust towards the surface.

The existence of local reservoirs of molten rock within the crust is even still more important in another connection, that is, in relation with the supposed 'average rate of increase of temperature with descent below

* The heat thus brought to the surface would amount to one-seventeenth of that conveyed by conduction.

the ground.' It is doubtful whether we have yet discovered a rate that in any useful sense can be spoken of as 'average.' The widely divergent views of different authorities as to the presumed value of this rate may well lead to reflection. The late Professor Prestwich thought a rise of 1° F.

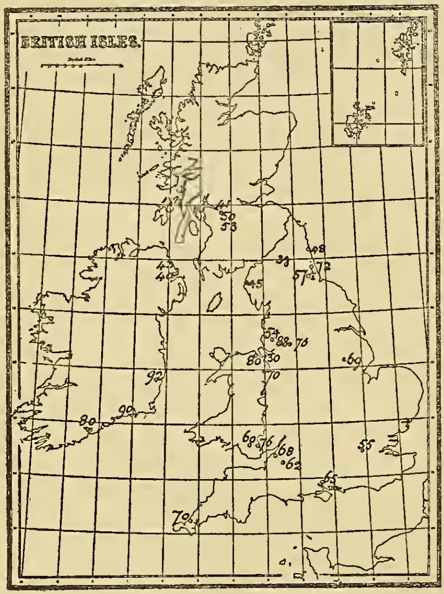


Fig. I.—Map of the British Isles, showing the distribution of rates of increase of temperature with descent. The rates are taken from the 'British Association Report,' except in the case of those in the south of Ireland.

for every 45 feet of descent below the zone of constant temperature best represented the average; Lord Kelvin in his earliest estimates has adopted a value of 1° F. for every 51 feet; the committee of this association appointed to investigate this question arrived at a rate of 1° F. for every 60 feet of descent; Mr. Clarence King has made calculations in which a rate of 1° F. for 72 feet is adopted; a re-investigation of recorded measurements would, I believe, lead to a rate of 1° F. in 80 or 90 feet as more closely approaching the mean. This would raise Lord Kelvin's estimate to nearly fifty millions of years.

When from these various averages we turn to the observations on which they are based, we encounter a surprising divergence of extremes from the mean; thus in the British Isles alone the rate varies from 1° F. in 34 feet to 1° F. in 92 feet, or in one case to 1° F. in 130 feet. It has been suggested, and to some extent shown, that these irregularities may be connected with differences in conductivity of the rocks in which the observations were made, or to the circulation of underground water; but many cases exist which cannot be explained away in such a manner, but are suggestive of some deep-seated cause, such as the distribution of molten matter below the ground. Inspection of the accompanying map of the British Isles, on which the rates of increase in different localities have been plotted, will afford some evidence of the truth of this view. Comparatively low rates of increase are found over Wales and in the province of Leinster, districts of relatively great stability, the remnants of an island that have in all probability stood above the sea ever since the close of the Silurian period. To the north of this, as we enter a region which was subject to volcanic disturbances during the Tertiary period, the rate increases.

It is obvious that in any attempt to estimate the rate at which the earth is cooling as a solid body the disturbing influence of subterranean lakes of molten rock must as far as possible be eliminated; but this will not be effected by taking the accepted mean of observed rates of increase of temperature; such an average is merely a compromise, and a nearer approach to a correct result will possibly be attained by selecting some low rate of increase, provided it is based on accurate observations.

It is extremely doubtful whether an area such as the British Isles, which has so frequently been the theater of volcanic activity and other subterranean disturbance, is the best fitted to afford trustworthy results; the Archæan nucleus of a continent might be expected to afford surer indications. Unfortunately the hidden treasures of the earth are seldom buried in these regions, and bore-holes in consequence have rarely been made in them. One exception is afforded by the copper-bearing district of Lake Superior, and in one case, that of the Calumet and Hecla mine, which is 4,580 feet in depth, the rate of increase, as determined by Professor A. Agassiz, was 1° F. for every 223.7 feet. The Bohemian 'horst' is a somewhat ancient part of Europe, and in the Przibian mines, which are sunk in it, the rate was 1° F. for every 126 feet of descent. In the light of these facts it would seem that geologists are by no means compelled to accept the supposed mean rate of increase of temperature with descent into the crust as affording a safe guide to the rate of cooling of a solid globe; and if the much slower rate of increase observed in the more ancient and more stable regions of the earth has the importance which is suggested for it, then Lord Kelvin's estimate of the date of the 'consistentior status' may be pushed backwards into a remoter past.

If, as we have reason to hope, Lord Kelvin's somewhat contracted period will yield to a little stretching, Professor Joly's on the other hand, may take some paring. His argument, broadly stated, is as follows: The ocean consisted at first of fresh water; it is now salt, and its saltness is due to the dissolved matter that is constantly being carried into it by rivers. If, then, we know the quantity of salt which the rivers bring down each year into the sea, it is easy to calculate how many years they have taken to supply the sea with all the salt it at present contains. For several reasons it is found necessary to restrict attention to one only of the elements contained in sea salt: this is sodium. The quantity of sodium delivered to the sea every year by the rivers is about 160,000,000 tons; but the quantity of sodium which the sea contains is at least ninety millions of times greater than this. The periods during which rivers have been carrying sodium into the sea must, therefore, be about ninety millions of years. Nothing could be simpler; there is no serious flaw in the method, and Professor Joly's treatment of the subject is admirable in every way; but of course in calculations such as this everything depends on the accuracy of the data, which we may, therefore, proceed to discuss. Professor Joly's estimate of the amount of sodium in the ocean may be accepted as sufficiently near the truth for all practical purposes. We may, therefore, pass on to the other factor, the annual contribution of sodium by river water. Here there is more room for error. Two quantities must be ascertained: one the quantity of water which the rivers of the world carry into the sea, the other the quantity or proportion of sodium present in this water. The total volume of water discharged by rivers into the ocean is estimated by Sir John Murray as 6,524 cubic miles. The estimate being based on observations of thirty-three great rivers although only approximate, it is no doubt sufficiently exact; at all events such alternations as it is likely to undergo will not greatly affect the final result. When, however, we pass to the last quantity to be determined, the chemical composition of average river water, we find that only a very rough estimate is possible, and this is the more unfortunate because changes in this may very materially affect our conclusions. The total quantity of river water discharged into the sea is, as we have stated, 6,524 cubic miles. The average composition of this water is deduced from analyses of nineteen great rivers, which altogether discharge only 488 cubic miles, or 7.25 per cent. of the whole. The danger in using this estimate is two-fold: in the first place 7.25 is too small a fraction from which to argue to the remaining 92.75 per cent., and next, the rivers which furnish it are selected rivers, *i. e.*, they are all of large size. The effect of this is that the drainage of the volcanic regions of the earth is not sufficiently represented, and it is precisely this drainage which is richest in sodium salts. The lavas and ashes of active volcanoes rapidly disintegrate under the energetic action of various acid gases, and among volcanic exhalations sodium chloride has been especially noticed as abundant. Consequently we find that while the proportion of sodium in Professor Joly's average river water is only 5.73 per million, in the rivers of the volcanic island of Hawaii it rises to 24.5 per million (Walter Maxwell, 'Lavas and Soils of the Hawaiian Islands,' p. 170). No doubt the area occupied by volcanoes is trifling compared with the remaining land surface. On the other hand the majority of volcanoes are situated in regions of copious rainfall, of which they receive a full share owing to their mountainous form. Much of the fallen rain percolates through the porous material of the cone, and, richly charged with alkalies, finds its way by underground passages towards the sea, into which it sometimes discharges by submarine springs.

Again, several considerations lead to the belief that the supply of sodium to the ocean has proceeded, not at a uniform, but at a gradually diminishing rate. The rate of increase of temperature with descent into the crust has continuously diminished with the flow of time, and this must have had its influence on the temperature of springs, which furnish an important contribution to river water. The significance of this consideration may be judged from the composition of the water of geysers. Thus Geyser, in Iceland, contains 884 parts of sodium per million, or nearly 160 times as much as Sir John Murray estimates is present in average river water. A mean of the analyses of six geysers in different parts of the world gives 400 parts of sodium per million, existing partly as chloride, but also as sulphate and carbonate.

It should not be overlooked that the present is a calm and quiet epoch in the earth's history, following after a time of fiery activity. More than once, indeed, has the past been distinguished by unusual manifestations of volcanic energy, and these must have had some effect upon the supply of sodium to the ocean. Finally, although the existing ocean water has apparently but slight effect in corroding the rocks which form its bed, yet it certainly was not inert when its temperature was not far removed from the critical point. Water begins to exert a powerful destructive action on silicates at a temperature of 180° C., and during the interval occupied in cooling from 370 to 180° C. a considerable quantity of sodium may have entered into solution.

A review of the facts before us seems to render some reduction in Dr. Joly's estimate imperative. A precise assessment is impossible, but I should be inclined myself to take off some ten or thirty millions of years.

We may next take the evidence of the stratified rocks. Their total maximum thickness is, as we have seen, 265,000 feet, and consequently if they accumulated at the rate of one foot in a century, as evidence seems to suggest, more than twenty-six millions of years must have elapsed during their formation. W. J. Sollas.

(*To be concluded.*)

THE GEOLOGICAL AND PALEONTOLOGICAL COLLECTIONS IN THE AMERICAN MUSEUM OF NATURAL HISTORY.*

This informal paper was prepared by the author (in the absence of Professor R. P. Whitfield, who has been curator of the Geological Department of the Museum for more than twenty-three years) at the request of the officers of Section E, so that members in attendance at the meeting of the Association might know in a general way what to look for on visiting the Museum.

The first series of valuable fossils to be acquired by the American Museum of Natural History was the Holmes collection from the Tertiary deposits of South Carolina. This included the types of the species described in Tuomey and Holmes' works.† The second important series to be put on exhibition was the set of eight mounted skeletons of moas from New Zealand, constituting the De Haas types of those birds. There are eight unmounted skeletons in the same collection, thirteen species being represented in all.

The main portion of the department's specimens is composed of the James Hall collection, the acquisition of which in 1875 placed the Museum in the lead among American institutions in respect to Paleozoic fossils, on account of the great number of types and figured specimens contained therein, such specimens being numbered by the thousand.‡ Especially noteworthy in the Hall collection, aside from the wonderfully rich New York series, are the Potsdam fossils from Minnesota and Wisconsin; Trenton forms from Wisconsin and Iowa, the unfigured types of which have been republished by Professor Whitfield with figures in the Memoirs of the Museum; Niagara fossils from Waldron, Indiana; corals from the Falls of the Ohio river; crinoids from Burlington, Iowa, and the remarkable Lower Carboniferous fauna of Spergèn Hill, Indiana, both of which last have been republished by Professor Whitfield with figures from the original types, the former in the Memoirs and the latter in the Bulletin of the Museum.

Other collections which may be mentioned are the Chazy and Fort Cassin fossils from the vicinity of Lake Champlain, containing types which have been described by Professor Whitfield in the Bulletin of the Museum; a complete set of the Vermont and New Hampshire rocks illustrating the geological survey of those States by Professor C. H. Hitchcock, and the types of the Tertiary plants from Brandon, Vermont; an excellent series of Paleozoic fossils from Illinois and neighboring States; fossils from the Cretaceous marls of New Jersey, collected and presented to the Museum by Professor Whitfield, and fine sets of fish remains from the Triassic of the Connecticut valley and the Tertiary beds of Wyoming. The most recent noteworthy addition is one of the Tyrrell collections of placoderm fishes from the Devonian rocks of Ohio.

The arrangement of the collection is that devised by Professor Whitfield when he came to the Museum, and it is worthy of careful consideration on account of the way it has stood the test of time and use. Beginning at the northeast corner of the hall (because that is beside what was originally the only entrance to the room and was understood to be the permanent main entrance thereto) the specimens are arranged stratigraphically in ascending geological order. Under the stratigraphic arrangement, the grouping is by geographical or lithological provinces, first New York, or eastern and

* Read before Section E of the American Association for the Advancement of Science, June 26, 1900.

† Pleiocene Fossils of South Carolina, by M. Tuomey and F. S. Holmes. 4to. Charleston, S. C., 1857; Post-Pleiocene Fossils of South Carolina, by F. S. Holmes. 4to. Charleston, S. C., 1860.

‡ Published principally in the reports of the State Geological Surveys of New York, Iowa, Wisconsin and Indiana.

then western. Under this again the arrangement is strictly biological, beginning with plants, where present, and then taking the animals in ascending scale. This scheme has been carried out most definitely in the upright cases, while the desk cases contain many of the best specimens and fit into the classification as well as is practicable. A part of each of twelve of the desk cases is occupied by specimens comprising the Dana's Manual series. These illustrate the figures in that standard work on geology and form an epitome of the historical side of the science. Many of the figures are represented by the very specimens from which the originals were drawn. Large specimens showing ripple marks, footprints, concretions, and other phenomena are placed on the tops of the cases and in other places out of series.

A very valuable feature of the installation is that of separating the biological units from one another, so that the individuals, species, genera, families, etc., which belong together can be distinguished on the most rapid inspection. This is effected by means of narrow strips of wood of different colors placed between the trays holding the fossils, single black strips separating different species, red ones genera, white ones families, two white ones limiting orders and two black denoting the boundaries of classes and higher subdivisions. The specimens, furthermore, are arranged so that one naturally examines them from left to right and from below upwards, except that the upper shelves of the upright cases are occupied by large and small specimens showing the grouping of the fossils in the rocks and the geological features of the beds. More than nine-tenths of the hall is devoted to the American forms, the rest being given up to a synoptic series of European fossils and fossils from other foreign localities.

The mineral collection, which is under the immediate care of Mr. L. P. Gratacap, has grown to large proportions and well repays careful study. About five hundred species are represented by nearly ten thousand specimens which are arranged according to the sixth edition of Dana's System of Mineralogy. The specialty of an institution like the American Museum is large, showy specimens, and we have a great many such which are worthy the notice of the scientific as well as the popular visitor. Especially conspicuous among these are specimens of quartz, gypsum, barite, calcite and fluorite, but above all the unrivaled malachites, azurites and stalactites from the Copper Queen Co.'s mines at Bisbee, Arizona. The collection of gems and gem material, too, should not be overlooked, since it contains many unique and beautiful specimens.

The Museum collections of the fossil remains of mammals and reptiles are in the Department of Vertebrate Paleontology, and being thus outside of my province, I refer to them with the permission of the curator of the department, Professor Henry F. Osborn. The exhibition series is to be found in the hall of the east wing of the Museum building, on the same floor with the collections of the Geological Department, and it includes many wonderful specimens, the like of which are to be found in no other institution in the world. The department was organized and the work of collecting begun in the year 1891 with Professor H. F. Osborn as curator, Dr. J. L. Wortman as assistant curator in charge of the field work, and Adam Hermann as head preparator. Thanks to the ability and energy of this corps of workers and their assistants, the collection has grown with great rapidity and substantiality, while the installation is a model.

The amount of exhibition material on hand and mounted in 1895 was sufficient to warrant the opening of the hall, and the public obtained the first view of these collections in October of that year. One of the constant aims of the curator has been to obtain complete skeletons for the exhibition cases; and an inspection of the cases will show the extent to which this aim has been attained. Pains and expense have not been spared in the effort to make the collection attractive in appearance, as well as useful to the student. The primary idea in the arrangement of this collection is to show the evolution of the various types of animals represented, while the geological association is secondary. Thus on the south side of the room we have the perissodactyls, beginning with the titanotheres and passing on through the tapirs, lophiodonts, rhinoceroses and paleotheres to the horses. On the north side of the room, and beginning, as before, at the west end of the hall, we have the amblypods (pantolambdas, coryphodonts and uintatheres), the elotheres, the oreodonts and the ancestors of the llamas and the camels.

Among the sets just mentioned are some specimens that deserve more than the passing notice that can be given them here. Cope's type specimen of *Phenacodus primævus*, the collateral ancestor of the hoofed animals, was acquired with the purchase of that famous scientist's collection of fossil mammals in 1895. It has been worked out of the matrix since it came to the Museum and mounted, so that every bone on one side can be removed readily for the purpose of examination or study. *Hophlophoneus primævus* Leidy, the ancient saber-toothed tiger, is represented by an absolutely complete skeleton, even the smallest bones of the tail having been preserved. This, too, has been mounted so that every bone can be readily removed for study. *Patriofelis ferox* Marsh, the ancient aquatic tiger-cat, *Coryphoden testis* Cope and *Palæosyops paludosus* Leidy are represented by specimens which are almost equally good. An immense Titanotherium skeleton, which has been made up from but two individuals, shows an interesting fracture of one of the ribs on the right side which was healed during the life of the beast. Four rhinosceros skeletons show the long-legged, agile and short-legged, sluggish types. These have been described by Professor Osborn in a Memoir of the Museum. The bones of one of these skeletons are so perfect that they hardly look like fossils. The evolution of the horse is represented by a series of skulls as well as by the more familiar series of leg bones.

The subject of reptiles is now receiving much attention and some remarkable specimens have been placed on exhibition, the most noteworthy of which is the nearly entire skeleton of a mosasaur (*Tylosaurus dispelor* (Cope)) from the Upper Cretaceous of Kansas. The individual must have been originally more than thirty feet in length. About twenty-eight feet of it have been preserved in this specimen, which has been mounted in the original matrix in which it was found and placed in a shallow case against the wall near the entrance to the hall. *Diplodocus*, *Camarasaurus* and other herbivorous and carnivorous dinosaurs from the western Jurassic and Cretaceous beds are represented in the cases by sets of vertebræ, pelvic bones, ribs and legs which give the visitor a very good idea of the immense size and the proportions of these ancient lizards.

In 1895 the mammal remains in Professor Cope's famous collection were purchased by the Museum, and in 1898 the remainder of his collection was acquired. These acquisitions brought to the Museum a large number of invaluable type specimens and established the position of the institution as one of the most important, if not the most important, place in the world for the study of vertebrate paleontology. Aside from these types, the collection contains, as a matter of course, all the material described and illustrated in the Bulletins and Memoirs of the Museum by Messrs. Osborn, Wortman, Matthew (W. D.), and Earle.

A description of this department of the Museum would be very incomplete without mention of the life-like water-color restorations of mammals and reptiles which have been made by Charles R. Knight, under the direction and with the advice and assistance of Professors Osborn, Cope and Scott. These pictures are, without question, the best attempts that have ever been made to represent the animal life and the scenery of Mesozoic and Cenozoic time in this country or Europe. The collection is very thoroughly labeled, with elaborate descriptive as well as individual labels and photographic transparencies of many of the western fossiliferous localities occupy some of the windows.

Edmund Otis Hovey.

SCIENTIFIC BOOKS.

Evolution by Atrophy in Biology and Sociology. By Jean Demoor, Agrégé of the Free University of Brussels; Jean Massart, Chargé de Cours of the Free University of Brussels; Emile Vandervelde, Professor at the Institute des Hautes Études of Brussels, translated by Mrs. Chalmers Mitchell. The International Scientific Series. New York, D. Appleton & Co. 1899.

An eminent American economist has declared the bankruptcy of biological sociology. The authors of 'Evolution of Atrophy,' have assumed the receivership of a section of biological sociology, namely, that dealing with degeneration. Realizing that "biosociological investigations have hitherto been conducted either by naturalists with a limited knowledge of social questions, or by sociologists whose training was incomplete and superficial," their researches on degeneration "have been made separately from the social side and from the biological side, and have now been coordinated and combined." The volume is divided into three books, dealing respectively with 'Universality of degenerative evolution,' 'The path of degenerative evolution,' and 'Causes of degenerative evolution.' Each book is divided into three parts, the third of which gives a summary and conclusions of the first two. The result of the collaboration of several authors has resulted in a well-systematized arrangement of topics and an attempt at balancing a part, chapter, or section in Biology with a similar one in Sociology. Thus Part I. of Book I. deals with 'Degeneration in the development of institutions and organs.' Chapter I. 'In the evolution of organs all modification is necessarily attended by degeneration.' Chapter II. 'In the evolution of institutions all modification is necessarily accompanied by degeneration,' and of Part I., Chapter I., 'All organisms exhibit rudimentary organs.' Chapter II. 'Survivals exist in all kinds of societies.' Or in Book II., Part II., Chapter I., we have: *Section I.* 'Disappeared organs.' *Section II.* 'Disappeared institutions.' There is thus a constant interlarding of fat with lean.

Book I. is essentially a statement of facts from which the authors conclude that "degenerative evolution exists everywhere * * * in the evolution of organs certain facts may disappear completely * * * in the evolution of organisms certain organs may also disappear. * * * Not only may a larval stage or an adult stage be completely suppressed, but a multicellular organism may even lose its power of dying." Degeneration is not an accident and is not confined to unusual, abnormal or pathological cases. Living and superior civilizations drag behind them a trail of débris from dead civilizations.

Book II. is an examination of the question whether the degeneration of individuals and of organs proceeds by successive atrophies occurring in the order opposite to that of ontological formation. In considering the series of pineal eyes offered by various animals they "cannot refrain from the conclusion that in this series degeneration retraces to a large extent the steps of original advance." This, however, is not a universal application, and "although the most recently acquired features may disappear first, degeneration is not an actual retracing of steps until the point of departure is reached. The degenerate condition is a new point, and really the term retrogressive evolution is misleading." "Rudimentary organs and institutions resemble the primitive states of these, in so far as they no longer possess certain parts which the primitive stages did not yet possess. None the less profound differences exist between the primitive and the reduced forms." This difference lies largely in the difference of potentiality of the primitive and the degenerate organ to vary in the direction of new uses. "After a certain degree of atrophy, there is no longer the possibility of re-development to resume old or to acquire new functions."

The Degeneration is in Book III. attributed to (1) lack of space; (2) lack of use; (3) lack of nutrition, as in the genitalia of neuter bees; (4) atrophy without apparent cause. If a functionless organ persists it is because neither variation nor selection has intervened. The struggle for existence between the various organs and the struggle for existence between various organisms are in the opinion of these authors 'the principal if not the sole agents in degeneration,' while inutility of function, insufficiency of nutriment or resource, and lack of space are occasional causes of degenerative evolution.

The book is written in a popular and entertaining style.

C. H. Eigenmann.

Sounding the Ocean of Air. By A. Lawrence Rotch, S.B., A.M. Romance of Science Series. London, Society for Promoting Christian Knowledge, and New York, E. and J. B. Young. 1900. Small 8vo. Pp. 184. $1.00.

The work in kite meteorology carried on during the past six years at Blue Hill Observatory under the direction and through the liberality of Mr. A. Lawrence Rotch needs no introduction to the readers of Science. Mr. Rotch's pioneer work in scientific kite-flying has received the stamp of official approval at the hands of the International Meteorological Conference and of the International Aeronautical Committee, and similar investigations have lately been begun at several of the European meteorological observatories. 'Sounding the Ocean of Air' is the attractive title of a little book, issued in the Romance of Science Series, which comprises six lectures delivered by the author before the Lowell Institute of Boston, in December, 1898. The subjects dealt with in the six chapters are 'The Atmosphere'; 'Clouds'; 'Balloons'; 'Ballons-sondes for Great Altitudes'; 'Kites,' and 'Results of Kite-Flights at Blue Hill.' The whole volume presents a clear and systematic account of the history and present status of the exploration of the free air. The last chapter, on the 'Results of the Kite-Flights at Blue Hill,' gives a useful summary, almost too condensed for understanding without careful study, of the notable results obtained by Mr. H. H. Clayton, of the Blue Hill Observatory staff, from the records made by the kite meteorograph. This chapter will, therefore, probably have the greatest interest for meteorologists, although the chapter on Clouds, in which the Blue Hill cloud work is given special attention, is hardly less important. This little book is to be recommended to all who wish to inform themselves concerning the work that is now being done in 'sounding the ocean of air,' as Mr. Rotch has happily phrased it. The volume emphasizes once again the high scientific quality of the work done by Messrs. Clayton, Fergusson and Sweetland, under Mr. Rotch's direction, at Blue Hill Observatory. The dedication is so appropriate as to deserve quotation here: "This little Book is gratefully dedicated to the late Augustus Lowell, Esq., of Boston, U. S. A., who, as Trustee of the Lowell Institute, enabled Scientific Men of Two Continents to present the Results of their Investigations to the Public."

R. DeC. Ward.

Harvard University.

Free-hand Perspective. By Victor T. Wilson. New York and London, Wiley and Sons; Chapman & Hall. 1900. 8vo. Pp. xii + 257. Ill., 139.

This is a work intended for use in a section of the free-hand classes of the drawing departments of technical schools and in similarly appropriate work. It is seldom that the writer of a book of this class can now expect to bring out anything essentially original in either matter or manner, or treatment generally. In this case, however, original genius has found expression, and we discover in Mr. Wilson's book some entirely new and very valuable matter;

while the system and tone of the discussion are characteristic of the expert in this department.

In consequence of the fact that the free-hand classes are usually formed before the student has studied descriptive geometry, the writer of this work had found it necessary to give him some introductory work in that branch, and it thus furnishes a valuable series of exercises introductory to the more formal treatment of that subject later. The book is, in fact, a discussion of the principles of linear perspective as employed in free-hand sketching. The illustrations throughout the book are especially interesting as being *fac simile* reproductions of such actual sketches, made with a free hand, in the course of regular class work. The departure from the absolute perfection of line obtainable with instruments is clearly observable ; but the accuracy of these lines, rectilinear and curvelinear, made by the unaided hand, is a beautiful illustration of the nicety with which the senses may be developed in this field. A comparison of Fig. 126 with the immediately succeeding sketches, all of which are of peculiar interest, illustrates this point. Nearly all the illustrations are curiously perfect, in line and in tone, as illustrative of free hand work.

The last chapter, 'Sketches from Working Drawings,' involves the most original of the author's inventions and the most helpful, to the student of mechanism. The methods of sketching from simple drawings are indicated and examples given, the principles of location of line and angle and plane are shown very clearly and a system is developed for the production of a perspective drawing of the object when the only data available are to be obtained from the ordinary plan and elevation of the working drawing of the shop. The perfection and the extensive applicability of this new system are well exhibited in the progression from Fig. 111 to Fig. 114, in which a steam engine crosshead is thus treated ; in Fig. 118 and Fig. 119, in illustration of a complicated casting for an engine-bed, and even more remarkably in Figs. 133–136, where a very difficult form of beam and bell-crank for a pumping engine is brought out. The teaching of this new art, to the young engineer, particularly, is likely to give him great facility in the reverse process of reading the working drawing, and it must prove very helpful; especially, where he is compelled to explain to the workman drawings of peculiar or complicated forms, and shapes difficult to picture in the mind's eye, as the pattern-maker and the finisher must picture every piece on which he is to work and with no other aid to his imagination than the plans and elevation of the working drawings.

Mr. Wilson has made a distinct advance in his art, an invention of striking interest, one probably of no small value.

R. H. THURSTON.

Our New Prosperity. By RAY STANNARD BAKER. New York, Doubleday & McClure Co. 1900. 12mo., pp. 267 ; many illustrations. Price, $1.50.

There is a class of books, illustrated by Carnegie's 'Triumphant Democracy,' Wright's 'Industrial Evolution of the United States,' Gannett's 'Building of a Nation,' and Dr. Strong's 'Our Country,' which should interest, absorbingly interest, every thinking man, especially every American citizen, and still more especially every young man. To this class belongs Mr. Baker's new book. It is a condensed and very impressive statement, based upon official statistics, of the conditions which have brought about the present extraordinary flood of prosperity in all industrial departments in this country, the good results that followed the trying period of 'hard times' of earlier years in the clearing off of old scores and reduction of the business of the country to a solid basis, the effects of the 'prosperity wave' at home and abroad, the development of the industries of the New South, the 'invasion of the world' by the exporters and manufacturers of the United States, and glances at the prognostications of a future, not likely to be free from trouble and an occasional retrogression, but on the whole one of enormous promise, and apparently of certain rise to as yet unimagined greatness. The statistical matter, which constitutes the main and fundamental portion of the work, comes from the Treasury Department bureaux, those of the Mint, the Labor Commissioner, the Geological Survey and the various other departments at Washington, with acces sions from the technical journals and from many experts among business men.

R. H. THURSTON.

GENERAL.

MESSRS. GAUDRY AND BARROIS and their confrères in France have brought out in the form of a guide-book to the geological excursions undertaken this summer under the auspices of the International Congress of Geologists, a veritable hand-book of the geology of France, entitled 'Livret-guide des Excursions en France du VIIIe Congrès Géologique Internalional.' The work is beautifully illustrated with reproductions from photographs, with cuts of sections and colored maps, making the collection of papers on the different geological provinces of the Republic by far the most complete publication of the kind for any country. The matter is presented in such a form that it will serve the reader as well as the geological traveler. Paper and press-work are of the best quality.

J. B. W.

IN the first part of his work 'Ueber Museen des Ostens der Vereinigten Staaten von Nord Amerika,' Dr. A. B. Meyer, the director of the Dresden Museum, describes the museums of New York City, Albany and Buffalo.

BOOKS RECEIVED.

Status of the Mesozoic Floras of the United States. LESTER F. WARD, with the corroboration of WM. M. FONTAINE, ATREUS WANNER and F. H. KNOWLTON. Washington, Government Printing Office. 1900. Pp. 213–430. Plates XXI–CXLIV.

A Practical Course in Mechanical Drawing. WILLIAM FOX and CHARLES W. THOMAS. New York, D. Van Nostrand Co. 1899. Pp. vi + 98.

Chemical Technology. Edited by C. E. GROVES and WILLIAM THORP, Vol. III. *Gaslighting.* CHARLES HUNT. Philadelphia, P. Blakiston's Son & Co. 1900. Pp. xviii + 312.

SCIENTIFIC JOURNALS AND ARTICLES.

The Botanical Gazette, October, contains an important paper by Dr. R. A. Harper, of the University of Wisconsin, on 'Cell and Nuclear Division in *Fuligo varians*,' a common slime mold. The results have led Dr. Harper to discuss in a general way the processes of cell division, and he discovers no such definite rules of cleavage as have been urged by authors. Mr. W. J. G. Land, of the Hull Botanical Laboratory, describes cases of double fertilization in *Erigeron* and *Silphium*, in both of which cases he discovered the second male cell conjugating with the endosperm nucleus or with one of the polar nuclei. The male cells of *Silphium* are remarkable in that they are much elongated and spirally coiled. Miss Mary Hefferan, of the Bacteriological Laboratory of the University of Chicago, describes 'A New Chromogenic Micrococcus,' discovered in the course of an examination of river water for the Sanitary District of Chicago. Mr. E. R. Hodson, of the Iowa Agricultural College, describes 'A New Species of *Neovossia*,' a smut affecting the ovaries of *Phragmites communis*. Mr. Henry Kraemer, of the Philadelphia College of Pharmacy, writes concerning the origin of tannins in galls, coming to the conclusion that the crystalline compound found in the galls which he examined is gallic acid, which becomes transformed into tannin.

The Auk, for October, has for its first article an account of 'A Nuptial Performance of the Sage Cock,' with a plate showing how the bird slides along on its breast with distended air sacs. J. A. Allen discusses 'Aptosochromatism,' reviewing the most recent articles on alleged change of color in feathers without moult, changes which Dr. Allen does not consider as taking place. James J. Carroll presents 'Notes on the Birds of Refugio County, Texas,' giving a list of 185 species, and William H. Kobbé in 'The Birds of Cape Disappointment, Washington,' gives an annotated list of 63 species. W. E. Saunders describes the 'Nesting Habits of the Cerulean Warbler.' J. A. Allen under 'North American Birds Collected at Santa Marta, Colombia,' presents a list of 43 species. Finally Jonathan Dwight, Jr., makes another of his important contributions to ornithology in 'The Moult of the North American Shore Birds (*Limicolæ*),' which has a very direct bearing on the question of change of color without moult. Dr. Dwight emphatically states that changes of color in plumage are the results of moulting and wear. There are the customary General Notes and Reviews of Recent Literature, and the number contains the Index to Volume XVII. It is noted that hereafter *The Auk* will be published by Edward W. Wheeler, 30 Boylston Street, Cambridge, Mass.

The October number (Volume 7, No. 1) of the *Bulletin of the American Mathematical Society* contains the following articles: Report of the recent summer meeting of the Society, by the Secretary; 'The Undergraduate Mathematical Curriculum,' report of the discussion at the Summer Meeting, by Professor W. H. Maltbie; 'On a Memoir by Ricardo de Paolis,' by Professor Charlotte Angas Scott; 'Notes'; and 'New Publications.' The November number of the *Bulletin* contains. 'The International Congress of Mathematicians in Paris,' report by Professor Charlotte Angas Scott; 'The Forty-ninth Annual Meeting of the American Association for the Advancement of Science,' report of the meeting of Section A, by Dr. G. A. Miller; 'Note on Geometry of Four Dimensions,' by Professor E. O. Lovett; 'Notes'; and 'New Publications.'

The October (closing) number of Volume 1 of the *Transactions of the American Mathematical Society* contains the following papers: 'On Surfaces enveloped by Spheres belonging to a Linear Spherical Complex,' by P. F. Smith; 'On Certain Relations among the Theta Constants,' by J. I. Hutchinson; 'On the Groups which have the same Group of Isomorphisms,' by G. A. Miller; 'Die Hesse'sche und die Cayley'sche Curve,' by P. Gordan; 'Application of a Method of D'Alembert to the Proof of Sturm's Theorems of Comparison,' by M. Bôcher; 'Two Plane Movements Generating Quartic Scrolls,' by E. M. Blake; 'The Invariant Theory of the Inversion Group: Geometry upon a Quadric Surface,' by E. Kasner; 'A Simple Proof of the Fundamental Cauchy-Goursat Theorem,' by E. H. Moore; 'Notes and Errata,' Volume I.

Cambridge University press will begin on the first of January next the publication of a quarterly *Journal of Hygiene*, to be edited by Dr. G. H. F. Nuttall, Lecturer in Bacteriology and Preventive Medicine in the University of Cambridge, Dr. John Haldane, F.R.S., Lecturer in Physiology in the University of Oxford, and Dr. Arthur Newsholme, M. O. H., Brighton.

SOCIETIES AND ACADEMIES.

AMERICAN MATHEMATICAL SOCIETY.

A regular meeting of the American Mathematical Society was held at Columbia University, New York City, on Saturday, October 27, 1900. Professor Thomas S. Fiske, Vice-President of the Society, occupied the chair during the two sessions. The total attendance amounted to thirty-two, including twenty-five members of the Society.

The Council announced the election of the following persons to membership in the Society: Professor George L. Brown, South Dakota Agricultural College, Brookings, So. Dak.; Mr. Charles H. Davis, New York, N. Y.; Dr. Derrick N. Lehmer, University of California, Berkeley, Cal.; Miss Ida M. Schottenfels, Chicago, Ill.; Professor Frank D. Sherman, Columbia University, New York, N. Y.; Mr. Burke Smith, Northwestern University, Evanston, Ill. Twenty-five applications for admission to membership were received.

In response to the invitation of Cornell University the Summer Meeting and Colloquium of the Society will be held at Ithaca, August, 1901.

The following papers were presented at the October meeting:

(1) Professor Maxime Bôcher: 'On linear dependence of functions of one variable.'

(2) Professor David Hilbert: 'Ueber Flächen von constanter Gauss'scher Krümmung.'

(3) Professor E. O. Lovett: 'Three notes on the geometry of contact transformations.'

(4) Dr. G. A. Miller: 'On a theorem in substitutions.'

(5) Professor S. L. Penfield: 'The solution of spherical triangles by graphical methods, and exhibition of scales and protractors for plotting.'

(6) Miss I. M. Schottenfels: 'On a set of definitional functional properties for the analytic function $f(z)=\frac{\tan \pi z}{\pi}$.'

(7) Professor P. F. Smith: 'Geometry within a linear spherical complex.'

(8) Dr. E. J. Wilczynski: 'Invariants of systems of linear differential equations.'

(9) Mr. H. W. Kuhn: 'Several theorems on imprimitive groups'

After the meeting several members of the Mathematical and Physical Societies dined and passed the evening together.

The next meeting of the Society will be the Annual Meeting for the election of officers, Friday, December 28, 1900.

F. N. Cole,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ON THE SUPERINTENDENCY AND ORGANIZATION OF THE COAST SURVEY.

In view of the fact that the superintendency of the U. S. Coast and Geodetic Survey is about to pass from the present incumbent to some successor, the following statements may be of interest:

First, as regards the selection of a superintendent. Here there ought to be no serious difficulty; for, although persons suitable and available for the position are not numerous, the appointing power is free to select from all who may become known to him. He is not, like the voter, practically confined in his choice to two or three nominees. It seems proper that scientific bodies (notably the National Academy of Sciences), if not called upon as advisers, should take the initiative and bestir themselves, in order that a suitable man for this important position may be selected. Let them at least formulate the requirements for the place; then he who best measures up to such requirements should be the one to be selected. Or, perhaps better still, an advisory committee of mathematicians, physicists and astronomers might be appointed by the Chief Executive from this Academy and the faculties of our leading universities. What is wanted is a man of mature intellect and broad and thorough scholarship. If possible, he should already have made for himself a substantial reputation in the scientific world—this would, in fact, be a proof of his thoroughness and perseverance. But let no man be selected whose sole claim is a little technical skill or a familiarity with the organization. This remark is in no wise intended to decry the importance of experience, whether in field, laboratory or observatory.

It is perhaps not very generally understood that the organization of the Survey is radically wrong or at least not such as should underlie a scientific bureau in our day and generation. Its one fatal defect is its semi-military character. I say *semi*-military because it is open to that favoritism so much complained of in our late Spanish War, without having the wholesome restrictions thrown about a purely military organization. This places a fortunate few in virtual control of the many. In some instances this might be excused on the ground of the necessities of the case; in other words, in certain matters there must be some head. But if the fortunate few are assumed to have, by virtue of their positions, a monopoly of all brain tissue, and so are made to constitute the sole advisers of the superintendent in all matters relating to the work of the Survey, and even in the elevation and degradation of the personnel, it becomes evident to any disinterested observer that no universal good-fellowship can exist—and without this, good scientific work is impossible.

Suppose this oligarchy were to fortify itself behind certain rules designed for bureaus whose work is chiefly clerical; then an employee not specially empowered to look after others must needs be very guarded in his associations with his co-workers. Thus it might readily come to pass that persons working for years in the office at allied work scarcely have a speaking acquaintance with one another. Free discussion of work between non-commissioned employees would probably be frowned upon as seditious or as nursing conspiracies. The dangers of such a system to scientific work and thought are so obvious to anyone that its defense can hardly be seriously entertained. But there are other dangers as well as a great injustice in the system; for the management might fall into the hands of unscrupulous parties. In matters purely scientific, if there is to be any subordination, the smaller intellects should do homage to the greater; and in matters in general, unless there are most cogent reasons to the contrary, the older and more experienced should have the directing of the younger. This is a law of natural instinct and is in accordance with the laws of logic and of ethics; it is not to be lightly set aside. But enforced or artificial superiority and inferiority might put inferior minds over the superior, and make tyros chiefs of divisions and of field parties.

In this brief space no elaborate scheme of reorganization will be attempted. But it is safe to say here that the following considerations are of fundamental importance:

1. Abolish all distinction between field and office force.

2. Leave all examinations or other tests of qualifications for appointment into the Survey wholly with the Civil Service Commission. If the Commission cannot propound suitable questions, let it consult the faculties of our leading universities. But let them never appeal to the bureau interested, save as to the general scope of the examination or other tests. If the bureau can dictate to the Commission, there is grave danger that it will override the latter and frame requirements suited to some person in whom it is interested. Again, ridiculously specific or technical questions do not well test a man's capacity nor his ability for doing work.

3. So far as possible, let the individuals do that kind of work for which they are best fitted because of their education, ability and natural liking.

4. Then base promotions in salary upon the quality and quantity of work done, unless it works obvious injustice to known abilities not well brought out by the assigned work.

5. The same rule should generally be applied in the selection of chiefs of divisions and of field parties. In doubtful cases favor the older candidates.

6. Let no set of employees have the ear of the superintendent while the other employees are seldom or never consulted.

7. Grant the greatest possible freedom in the pursuit of the work. Favor, and do not discourage, free consultation between all members of the Survey.

The preceding remarks show that much depends upon the selection of a superintendent. They show how important it is that he should be a scholarly man capable of properly judging the merits of the persons employed, also that he should encourage scientific activity as generally as possible throughout the bureau.

OBSERVER.

NOTES ON INORGANIC CHEMISTRY.

An interesting paper by J. C. A. Simon Thomas, on the liquid carbon dioxid of commerce, has recently appeared in the *Zeitschrift für angewandte Chemie*. The author was incited to his investigation by the widely varying prices for the liquefied gas as supplied in steel cylinders for use in the ice machines on Dutch men-of-war. The gases examined were obtained from combustion of coke (Ozouf's method), from magnesite, from carbonaceous rock, 'prepared artificially' (no further data obtainable), and from the natural carbonic acid gas from certain volcanic regions. Gas from brewery fermentation was not obtained. The gases were all found to be of fairly good quality. No sulfurous acid gas nor hydrogen sulfid was found in any case. The natural gas contained considerable water, but this was probably introduced accidentally into the cylinder. The other gases left little, if any, residue. The natural gas was almost perfectly pure, containing only a trace (0.8 per cent.) of air. The Ozouf gas and that from carbonaceous rock contained respectively 2 per cent. and 5.7 per cent. of air. That from magnesite and that artificially prepared contained 4 per cent. and 3.4 per cent. of carbon monoxid. This was doubtless due to the presence of the reducing materials used in the decomposition. This impurity should not be present when the gas is used in ice machines in confined spaces, as on men-of-war, as the machines are liable to leak when first set to work. These quantities of impurities are found in the first portions of the gas drawn from the cylinders, and after half the gas has been drawn off, the amount of gas unabsorbed by caustic potash is inappreciable. The result of this investigation is to show that the quality of liquid carbon dioxid furnished by the European manufacturers leaves little to be desired.

Since the investigation of the metallic carbids by Moissan, the electric furnace has been applied to the preparation of many compounds of a similar nature, and some of these, like calcium carbid and carborundum, have already found important industrial applications. A paper was read before the Chemical Section at the Bradford meeting of the British Association by C. S. Bradley, on a series of silicids discovered by Charles B. Jacobs of New York, which may prove to be of commercial value. They are silicids of calcium, strontium and barium, with the formulæ $CaSi_2$, $SrSi_2$ and $BaSi_2$, thus corresponding to the carbids. They are formed in the electric furnace from mixtures of the carbonates with sand, and sufficient carbon to effect a reduction, or silicates of the alkaline earths and carbon may be used. When treated with water, hydrogen is evolved; with dilute acids the calcium compound evolves silicon acetylene, Si_2H_2. They are powerful reducing agents, and may find use in the dye-stuff industries. They have also been found to be effective in removing phosphorus and sulfur from molten steel.

A RECENT issue of the *Chemical News* gives a description of the electrolytic refining plant of Boston and Montana Copper and Silver Mining Company of Great Falls, Montana, and of the Anaconda Copper Mining Company. It is an excellent instance of the revolution which is being worked in many industries by the use of electricity. In these plants the ore is ground and concentrated, and the rough metal is then cast in pigs two feet square and two inches thick. These are used as the anodes in the bath, the kathodes being thin sheets of copper. The refined copper is deposited upon these thin sheets, while the refuse from the pigs falls to the bottom of the bath. This refuse consists chiefly of lead, silver and gold, and is said to be worth about $2,600 a ton. This refuse is sufficient to pay for the whole electrolytic process. The process is carried on without intermission and the effective result is seen in the dividends of these companies.

J. L. H.

RECENT ZOO-PALEONTOLOGY.

A RHINOCEROS WITH A COMPLETE SET OF CUTTING TEETH.

THE chronometer of evolution never errs. It is well known that modern rhinoceroses are distinguished by the loss of most, if not all, of their cutting teeth. On evolution principles it has been predicted that they sprang from ancestors with four cutting teeth.

A few years ago the American Museum party found a maxilla containing the ancestral upper canines, and now F. A. Lucas (*Proc. U. S. Nat'l, Mus.*, No. 1207) has described a still older type, *Trigonias osborni*, with a full set of upper cutting teeth, that is, canines and three incisors, the most anterior of which is enlarged, Fig. 1. In the lower jaw there is some evidence that the enlarged teeth, which have been usually described as canines, are really incisors, because

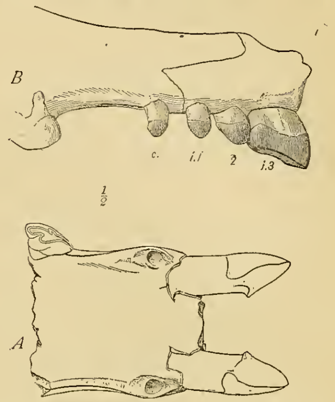


FIG. 1.—*Trigonias osborni*. *A*. Jaw showing alveoli of supposed canines. *B*. Anterior portion of cranium, showing three incisors and small canine. After Lucas.

vestiges of small teeth are present just behind them. This is a most interesting discovery from the Lower Oligocene beds of South Dakota and carries the line of the Rhinoceroses one step further back. The animal is almost as large as the classic *Aceratherium occidentale* of Leidy.

EXTINCT LEMURS FROM MADAGASCAR.

DR. C. J. FORSYTH MAJOR has described from time to time the remarkable lemurs of ancient Madagascar, a zoological region otherwise known as 'Lemuria'; they are of Pleistocene age and show a high degree of specialization or adaptive radiation. *Megaladapis* (see *Phil. Trans.*, Vol. 193, pp. 47–50, 1900) is by far the largest monkey hitherto described; as the name implies, it imitates on a large scale the well-known *Adapis* of the Oligocene of France. Another type, *Nesopithecus* (*Proc. Zool. Soc.*, Dec. 19, 1899), is remarkable in its adaptive resemblance to the Hypsiprimnid marsupials of Australia, proving that the lemurs are a group which in past time imitated other groups more closely.

PAREIASAURIANS OR THERIODONTS IN NORTHERN RUSSIA.

A Russian naturalist, Amalitzky, has made extremely important discoveries in northeastern Russia of a Permian fauna which resembles in part that of Scotland and of this country, but still more closely that of the Permian or Perm-Trias fauna of South Africa. In a recent paper before the Society of Naturalists of St. Petersburg, Dec. 28, 1899, he reports the discovery of 39 groups of bones in concretions, 5 of which are composed of complete skeletons, with 5 others more or less complete, and 10 large groups of scattered bones. They include horned types similar to *Elginia* of Scotland and *Dicynodon* of South Africa. Although imbedded in a very difficult matrix, probably the animals are in a remarkable state of preservation and they will not only add greatly to our knowledge of this important fauna, which is ancestral to all the modern reptiles, amphibians and mammals, but they actually afford the most striking evidence of the cosmopolitan distribution of land vertebrates in Permian times.

FOSSIL MAMMALS FROM EGYPT.

Africa is the dark continent of Vertebrate Paleontology. With the exception of the Permian fauna of the South, and the Pleistocene fauna of the extreme North (which was virtually a part of Europe), Africa is a blank, although there is little doubt that a most important evolution of mammals was in process there from the beginning of the Tertiary period. It is therefore of great interest to record the discovery, 100 miles nearly due west from Cairo, of a species of Anthracothere to which the name *Brachyodus africanus* is given by Mr. Andrews.* The horizon is Lower Miocene and the beds are alternating fluviatile, marine and lacustrine deposits.

EXTINCT BIRDS OF PATAGONIA.

We are also indebted to Charles W. Andrews (*Trans. Zool. Soc.*, London, October, 1899) for a very careful review of the fossil ratite birds of Patagonia, remarkable for their great size and their incomplete parallelism with the ratites of other countries. These birds do not, like many other fossils which have recently been discovered in South America, add to the series of animals which connects this continent with Australia and New Zealand. On the other hand, they are, according to Mr. Andrews, entirely of independent origin. In fact, he concludes: "In the preceding pages only a few of the types with which the fossils have been compared are mentioned, they being the only types to which any resemblance pointing to possible affinities could be made out. And even among these there are some to which the similiarity is so slight that they also might perhaps have been omitted. For instance, in the case of *Diomedea*, it is only in the structure of the palate and one or two other points in the skull that any similarity with *Phororhacos* can be detected, the rest of the skeleton being strongly against any such relationship. In fact, it seems to the writer that the only groups that really come into question are the Falconiformes and aberrant Gruiformes, Carima, Chunga, and to a less degree Psophia." The general appearance of the skull is like that of the Falcons, while the general structure of the skeleton, particularly of the pelvis and hind limbs is strongly in favor of affinity with the storks and cranes. The especial type studied, *Phororhacos*, stands in somewhat the same relation to the Cariamidæ (Crested Screamer, Chunga) as such forms as Glyptodon stand to the modern Armadillos.

* *Geol. Mag.*, Decade IV., Vol. VI., p. 481 f.

RELATION OF SOUTH AMERICAN AND AUSTRALIAN MARSUPIALS.

R. Lydekker (*Proc. Zool. Soc.*, 1899, pp. 927), while discussing the dental formula of marsupial and placental carnivores, states as his opinion, that the Prothylacinidæ, of Patagonia, equivalent to the Sparassodonta of Ameghino, are undoubtedly marsupials and that they are not very far removed from the Dasyures of Australia, of which they may represent the ancestral type. Lydekker also recedes from his former position that all the Mesozoic mammals should be classed as marsupials in the strict sense.

He has recently described *Ibid*, p. 919 f. from Chubut, Patagonia, a new Dolphin to which the name Prosqualodon is given because of the resemblance of its teeth to those of Squalodon. The same author has previously described Argyrodelphis, so that this is the second primitive cetacean from this region.

LARGE TURTLES FROM THE FORT PIERRE OF SOUTH DAKOTA.

G. R. Wieland has recently given a full description (*Amer. Jour. Sci.*, April, 1900) of his genus *Archelon* which he proves to be related to, but distinct from, *Protostega*. It comes from the Fort Pierre of South Dakota, both the skull and part of the skeleton being remarkably preserved. This great sea tortoise belongs to the family Protostegidæ Cope, but its relations to the modern sea turtles or Chelonidæ cannot yet be positively ascertained. None the less this family (Protostegidæ) is much nearer the Chelonidæ than is the existing family, Dermochelyidæ, or modern leather-backed tortoises. In other words, Wieland differs from Baur, who placed the genus *Spahrgis* near the marine turtles, and inclines to the view of Cope and Boulenger that they belong in the separate division Atheca.

DINOTHERIUM GIGANTISSIMUM.

(Anuarulu Museului De Geologia si de Paleontologia * * * 1894, 1896.)

This memoir is accompanied by a very interesting and complete history of *Dinotherium* and of the remarkable theories which have been entertained at various times as to the relationships of this animal. Although the genus has been known for half a century, there being three species: *Dinotherium cuvieri*, characteristic of the Lower Miocene; *Dinotherium bavaricum*, characteristic of the Upper Miocene, and *Dinotherium giganteum*, characteristic of the Lower Pliocene of Europe, little has been known of these animals except the skull, so that their relations to the other Proboscidia have been very obscure. Professor Stefanescu, of Bucharest, has recently described a species from the Pliocene, which, as its name indicates, is much larger than *Dinotherium giganteum*. The type is remarkably preserved and shows that, wholly unlike the elephant, this animal has a functionally tridactyl pes, the first digit and probably the fifth being greatly reduced. The skeleton was exhumed in Roumania, near the village of Mansati, between 1890 and 1894.

FOSSIL CAMELS OF EUROPE.

The same author has recently described a fossil camel from Roumania, the first which has been known in Europe; previous remains have been found in the Pliocene Siwalik beds of India, in the Pleistocene of Algeria and in the Pleistocene of Siberia, the latter teeth being preserved in the Museum of Darmstadt, and described by Bojanus in 1836 as *Merycotherium sibiricum;* the fossil nature of these teeth is somewhat in question. There can be no doubt however about the discovery in Roumania because the bones were associated with those of an Antelope and a Mammoth. After a most careful comparison and description, M. Stefanescu remarks that the animal probably emi grated from Asia but did not find its way into Europe until the Pleistocene; this species therefore adds a very important new type to the Pleistocene fauna of Europe.

THE DEVONIAN LAMPREY AND THE CLASSIFICATION OF THE FISHES.

Part 1 of Vol. II. of the *Memoirs* of the New York Academy of Sciences contains an important study of *Palæospondylus* by Bashford Dean. Since its discovery by Traquair in 1890 in the Devonian of Scotland, this minute fossil has attracted an amount of attention in inverse proportion to its size. Traquair placed it with the Cyclostomes; Huxley, with the larval Coccosteans; Gill, in a new sub-class, Cycliæ. Dean reviews the discussion and re-studies all the material with great care, coming to the conclusion that the specimens hitherto found are not adult: 'It is far more likely to prove, as Huxley believed, a larval Arthrodire.' The Arthrodira include the armored fishes *Dinichthys* and *Coccosteus*, and the most striking as well as the most permanent feature of Dean's paper is a separation of these types into a new distinct sub-class, Arthrognathi, distinguished by the hinged condition of the jaws both at their junction with the skull and with each other. This is probably an important advance in the classification of the fishes and it has already been accepted by Woodward and Eastman.

Henry F. Osborn.

SECTION OF HORTICULTURE AND BOTANY OF THE ASSOCIATION OF AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The meeting of the Section of Horticulture and Botany of the Association of Agricultural Colleges and Experiment Stations convened in New Haven, Connecticut, November 13th, with S. A. Beach, as Chairman, and Professor P. H. Rolfs, as Secretary. The program was as follows:

1. 'The Function of the Station Botanist,' Dr. George E. Stone, Amherst, Mass.; Discussion led by Professor P. H. Rolfs, Clemson College, S. C.

2. 'Plant Physiology in its Relation to Agriculture and Horticulture,' Albert F. Woods, Chief of Division of Vegetable Physiology and Pathology, Washington, D. C.

3. 'Grasses and Forage Plant Investigation in Experiment Stations and the Division of Agrostology,' Thomas A. Williams, Division of Agrostology, Washington, D. C.

4. Instructional Work. (*a*) 'Laboratory and Field Work for Students in Horticulture,' Professor E. S. Goff, Madison, Wis. (*b*) 'The Nature Study Movement,' Professor L. H. Bailey, Ithaca, N. Y. (*c*) 'The Educational Status of Horticulture,' Professor Fred. W. Card, Kingston, R. I.

5. Variety Testing and Plant Breeding. (*a*) 'Progress of Variety Testing in Experiment Station Work,' Professor F. William Rane, Durham, N. H. (*b*) 'What our Experiment Stations have done in Originating Varieties of Plants by Crossing and Selection,' Dr. B. D. Halsted, New Brunswick, N. J. (*c*) 'The Relation of the Section of Seed and Plant Introduction to Experiment Stations,' Jared G. Smith, Section of Seed and Plant Introduction, Washington, D. C. (*d*) Discussion led by Dr. Walter T. Swingle, Washington, D. C., and Professor Willet M. Hays, St. Anthony Park, Minn.

6. 'A Vegetable House arranged for Pot Experiments,' Mr. W. E. Britton, Horticulturist, New Haven, Conn.

THE ANNUAL CONGRESS OF THE GERMAN ANTHROPOLOGICAL SOCIETY.*

The Thirty-first Congress of the German Anthropological Society was held in the University town of Halle from September 24–27. In addition to its rich University collections, a special interest is attached to Halle as being the seat of the oldest German society for encouraging the study of natural science, viz., the Leopoldina-Carolina Academy, which is thus comparable to the Royal Society in this country. To the students of prehistoric archeology, the Prussian province of Saxony is chiefly interesting from the fact of the existence of the copper-mines at Eisleben, some little distance from Halle. The meetings were held under the presidency of Professor Virchow, assisted by Professor Ranke. At the opening session on Monday, September 24th, the presidential address (dealing with the general progress of anthropological study and teaching) was followed by a series of addresses from representatives of the University and town of Halle, of which that of the local secretary, Dr. Förtsch, is particularly noteworthy as containing a sketch of local prehistoric archeology, a field of research in which Dr. Förtsch has been particularly active, and which he has popularized with evident success. Of the subsequent communications to the Congress, the majority which dealt with archeology, there appear to us most worthy of mention the discussion opened by Professor Virchow on the 'Earliest Appearance of the Slavs in Germany,' and the account (illustrated with excellent lantern slides) given by Dr. Birkner (Munich) of the investigation of the graves of the German emperors in Speyer. Professor v. Fritzsch (Halle) and Dr. Lehmann-Nitzsche (La Plata) rendered interesting accounts of discoveries of prehistoric man in Thüringia and in the Argentine respectively, the latter record being still the subject of investigation as regards the exact antiquity (Tertiary period) claimed for the find.

It is a matter of some surprise that the department of physical anthropology should not have been the subject of more papers than were actually presented at Halle, which University claims the two Meckels and Welcker among its former professors of anatomy. The chief contributions to this subject were those of Dr. Schmidt-Monnard (Halle) on the relation between the growth and the weight of children of both sexes; of Dr. Eisler (Halle) on the *Musculus sternalis*; and of Professor Klaatsch (Heidelberg) on the method of research adopted by anatomists, illustrated specifically by obser-

* From *Nature*.

vation on the 'short head' of the Biceps femoris muscle in the mammalian series.

The chief excursion of the Congress was made on Wednesday, September 26th, to Eisleben, where the copper mines already referred to were visited, and demonstrations of copper-smelting were given by representatives of the Mansfield Co. Subsequently the local collection of prehistoric pottery, etc., was inspected.

The concluding session was held on September 27th, when the presidency (for the ensuing year) was assumed by Professor Waldeyer (Berlin). It is a matter of interest to note that the Congress was made the occasion of circulating 'special inquiry' sheets regarding the structure and building of boats in all parts of Germany. General proposals regarding cartography and systematic records for provincial localities were brought forward by Dr. Voss (Berlin).

In addition to the anthropologists already mentioned in the foregoing notes, there were present Freiherr v. Andrian-Werburg (Vienna), Professor Hein (Vienna), Professor Montelius (Stockholm), Professor Koganei (Tokio), and others to the number of about 120.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR SCHIAPARELLI retired on November 1st from the directorship of the Observatory at Milan, where he has been at work for the past forty years. His successor is Professor Celoria, heretofore assistant astronomer at the Observatory.

THE vacancy caused by the death of William Saunders, for the past 38 years superintendent of Experimental Gardens and Grounds, U. S. Department of Agriculture, has been filled by the appointment of B. T. Galloway, who in turn has been succeeded by Albert F. Woods as chief of the Division of Vegetable Physiology and Pathology.

DR. T. A. GEDDES, of the Bureau of Animal Industry, Department of Agriculture, has been detailed as a special inspector and ordered to Great Britain to inspect cattle intended for importation into the United States. Dr. Geddes sailed on November 7th.

PROFESSOR FREDERICK STARR, of the University of Chicago, has received a silver medal from Queen Wilhelmina, of Holland, as an acknowledgment for the anthropological collection sent by him to the National Museum of Holland.

DR. W. C. RÖNTGEN has written from Munich, under date of October 3d, a letter to the President of Columbia University, of which the following is a translation :

From the Secretary of our University I received yesterday the Barnard Medal awarded to me, together with your esteemed letter of June 13th.

Through the bestowal of this medal by a scientific institution, so illustrious as Columbia University, acting in conjunction with the National Academy of Sciences, my work upon the X-rays has received a recognition which, though in my own estimation greater than it deserved, has nevertheless pleased me very much and will be a spur to further effort.

Permit me, Mr. President, to request you to convey to Columbia University my warmest thanks.

MR. WILLIAM ANDERSON, professor of anatomy to the Royal Academy of Arts, London, died on October 27th at the age of fifty-eight years. He was the author of numerous contributions to anatomy and surgery, and the relation of these sciences to the fine arts. He was for some years director of the Naval Medical College at Tokyo, where he made valuable collections now in the British Museum.

DR. JOSEPH MIK, a distinguished dipterologist, died at Vienna on October 13th at the age of sixty-two years.

SURGEON MAJOR REED and a board of experts will continue the investigation into the propagation of yellow fever by mosquitoes, and an experimental station will be established outside Havana.

THE Secretary of Agriculture has published the following general order : "For the purpose of unifying the work of certain branches of the Department, it is hereby ordered that the Chief of the Division of Vegetable Physiology and Pathology, the Chief of the Division of Agrostology and the Chief of the Division of Pomology confer upon all matters of general policy and plan with the Superintendent of Experimental Gardens and Grounds, who is hereby designated as Director of Plant Industry. In carrying out this order the several branches of the Department named will maintain their present integrity and organization." A laboratory for the physical and chemical study of road materials has been established in the Division of Chemistry. "The object of the establishment of this laboratory is to secure the widest possible knowledge of the nature of road materials, their resistance to stress, their hardness, their power of absorbing water, their deportment in freezing temperatures, their cementing properties when reduced to powder, either alone or when mixed with other substances, their chemical composition and their geological origin and distribution."

It is reported that M. Daniel Osiris, a Greek millionaire, residing in Paris, has instituted a prize on the lines laid down by Mr. Nobel, though his offer is for Frenchmen only, except in a Paris Exposition year, when it becomes universal. He has set aside a sum to be awarded every three years in perpetuity to the discoverer, inventor or producer of the most noteworthy idea or object for the benefit of humanity. The prize is to be never less than 100,000 francs, and may be double that sum.

Edgar J. Townsend, professor of mathematics, and Cyril G. Hopkins, professor of agronomy, have returned to the University of Illinois after a leave of absence. Both have been studying during their absence abroad at the University of Göttingen, from which institution each has received the degree of Ph.D. Professor Townsend studied pure mathematics under Professors Hilbert and Klein and the mathematics of physics under Professor Voigt. Professor Hopkins has been studying under Professor Tollans.

Professor B. B. Ross, of the Alabama Agricultural and Mechanical College and Experiment Station, has been granted a year's leave of absence, which he is spending in chemical investigation in Germany.

Professor F. W. Woll, chemist of the Wisconsin Experiment Station, is spending a year in special study abroad.

President Henry S. Pritchett, of the Massachusetts Institute of Technology, made an address on November 8th before the Boston Society of Arts on 'America's Contribution to the Knowledge of the Size and Figure of the Earth.'

Mr. L. B. Stillwell, formerly electrical director of the Niagara Falls Power Company, and now in charge of the electrical installation work of the Manhattan Railway Company, has been appointed electrical director of the New York Rapid Transit Subway Construction Company.

In memory of the late Dr. R. T. Manson, F.G.S., the naturalist and geologist, a large granite boulder, has, as we learn from *Nature*, been taken from the bed of the River Tees and placed on a pedestal in the Public Park, Darlington. The stone weighs about twelve tons, and it is admitted to have come originally from Shap, in Westmoreland, in the Great Ice Age.

The well known collection of mammals of E. A. and O. Bangs, comprising more than ten thousand specimens (in most cases skins accompanied by skulls) and over one hundred type specimens, has been presented to the Museum of Comparative Zoology of Harvard University through friends of the Museum.

There has been recently received at the National Zoological Park, Washington, D. C., a specimen of Steller's sea-lion (*Eumetopias stelleri*), from the Pribilof Islands.

It is stated that the German Government has purchased Count Zeppelin's airship and that it will be taken to Berlin.

The Indian Government will give an annual subsidy of £650 for three years to the Pasteur Institute at Kasouli, of which Major Semple is director.

The daily papers report that Dr. Leopold Kann has arrived at Dundee on the Whaler *Eclipse*, bringing news, not only of Dr. Robert Stein and Mr. Samuel Warmbath, but also of Lieutenant Peary and Captain Sverdrup. Lieutenant Peary is said to be now wintering at Fort Conger and has apparently put off his attempt to reach the far north until next year. Captain Sverdrup, on the *Fram*, is said to be wintering in Jones Sound.

St. Petersburg scholars are planning a scientific expedition to examine the manuscripts at

Moukden, discovered by Russian troops, among them being ancient Greek and Roman documents, supposedly taken by the Mongolians on their retreat from the Occident. They are believed to be of great historical value.

THE Peabody Museum is sending this week an expedition to continue the work of exploration in the ruined and prehistoric city of Copan, in Central America.

THE United States Civil Service Commission invites attention to the fact that in view of the statement of the Department of Agriculture that no appointment is expected to be made at present to the position of assistant biologist, the examination scheduled for November 20, 1900, for the position of assistant biologist in the Department of Agriculture, will not be held at that time and not until further notice.

FROM a private letter the following paragraph of interest to astronomers is taken: "The latest news concerns the building of a fine new meridian circle by Repsold for the observatory at Kiel. It is to be of eight inches aperture with all possible modern improvements; a full equipment of collimators, wires, etc. Of the latter two are to be at 60 meters distance and a third at 4,000 meters. There is to be a floating mirror suspended over the instrument for observations to supplement the usual nadir observations. The building is to be semi-cylindrical with double walls about 12 meters square, and if I understand the matter correctly, the entire building is to be in two parts, so that the slit for observations is formed by separating the parts in the east and west direction. Professor Harzer is responsible for the design, I believe. The purpose for which the instrument is designed is the observation of faint, close circumpolar stars for latitude variation according to the method which has been used at the Paris Observatory, and the Prussian government is to furnish the money."

THE *London Daily Mail* states that the postal departmental commission will shortly report, after some months of deliberation, in favor of the earliest possible adoption of Marconi's system of wireless telegraphy by the postal authorities. The commission is also arranging terms for the acquisition of the Marconi patents, and negotiating with France and Germany regarding their attitude toward Marconi's inventions.

A FURTHER item of interest in regard to the Marconi system is the statement that when the Ostend-Dover mail packet *Princess Clementine* was nearing Dover, on November 9th, a message was received on board from La Panne. It was retransmitted to the Marconi station at Dover Court, in Essex, more than eighty miles distant.

THE Pennsylvania Experiment Station has for some time been engaged in the construction of a respiration calorimeter on the general plan of the Atwater-Rosa respiration calorimeter, but adapted in size and mechanical arrangement to use in investigations with the larger domestic animals. In the experiments with man many of the operations are performed by the subject himself, but the problem in experiments with animals is much more complicated. Accordingly the adaptation of the apparatus to animals has called for the exercise of much ingenuity in providing devices which will make the apparatus more largely automatic, or allowing all the operations connected with an experiment to be managed from without the respiration chamber. The apparatus is approaching completion. After being thoroughly tested it will be used for studying the fundamental problems connected with the nutrition of live stock. Comparatively little work of this character has as yet been done by the American experiment stations, and it is hoped that with the aid of this new apparatus the Pennsylvania Station will be able to achieve important results in a field where there is every year more pressing demand for exact information.

THE Association of Agricultural Colleges and Experiment Stations is this week meeting at New Haven under the presidency of Dr. Joseph E. Stubbs, president of the Nevada State University.

AT a recent meeting of the Röntgen Society in London, Dr. J. B. Mackintyre stated that medical men were disappointed at the limited value of the X-rays in medical work. In the army hospitals in South Africa, however, the X-rays were found most useful. Seventeen sets of apparatus had been sent to the field. They were now being adopted and supplied to all the larger military hospitals.

At the tenth annual meeting of the British Astronomical Association, held on October 31st, Mr. W. H. Maw referred to the observations made on the solar eclipse and spoke at length of the automatic appliances for obtaining photographs which Professor David P. Todd of Amherst College has devised and which he used with success this year. Professor Todd hopes to employ his apparatus on a more extended scale in observations of next year's eclipse in Sumatra.

At the last meeting of the Congress of American Physicians and Surgeons a committee was appointed to urge upon Congress the repeal of those provisions of the War Revenue Act of 1898 which lay a tax on legacies to educational, charitable and religious organizations. The committee, which consists of Professors Frederick C. Shattuck, Abraham Jacobi and William H. Welch, has written to the members of the Congress asking them to take an active interest in the subject by addressing members of the Senate and House of Representatives. Others interested in education and science should unite in the efforts for the repeal of this legislation.

The government of Argentine has published a decree declaring that Villa Concepcion is infected with the plague, and that other Paraguayan ports are suspicious.

In the French Senate M. Piot has introduced a bill aiming to arrest the depopulation of France. It provides for a tax on celibates of both sexes after they reach the age of 30, and upon childless couples who have been married for five years, the tax to be maintained until a child is born to them.

A communication on the influence of the temperature of liquid hydrogen on bacteria was recently presented to the Royal Society by Dr. Allan Macfadyen and Mr. Sydney Rowland. In a previous communication these gentlemen had shown that the temperature of liquid air has no appreciable effect upon the vitality of micro-organisms, even when they are exposed to this temperature for one week (about — 190° C.) They now report, we quote from the *British Medical Journal*, that they have been able to execute preliminary experiments as to the effect of a temperature as low as that of liquid hydrogen on bacterial life. As the approximate temperature of the air may be taken as 300° absolute, and liquid air as 80° absolute, hydrogen as 21° absolute, the ratio of these temperatures roughly is respectively as 15 : 4 : 1. In other words the temperature of liquid hydrogen is about one-quarter that of liquid air, just as that of liquid air is about one-quarter of that of the average mean temperature. In subjecting bacteria, therefore, to the temperature of liquid hydrogen, the experimenters place them under conditions which, in severity of temperature, are as far removed from those of liquid air as are those of liquid air from that of the average summer temperature. By the kindness of Professor Dewar the specimens of bacteria were cooled in liquid hydrogen at the Royal Institution, the following organisms being employed : B. acid lactici, B. typhosus, B. diphtheriæ, proteus vulgaris, B. anthracis, B. coli communis, staphylococcus pyogenes aureus, spirillum choleræ, B. phosphorescens, B. pyocyaneus, a sarcina and a yeast. These organisms in broth culture were sealed in thin glass tubes and introduced directly into liquid hydrogen contained in a vacuum jacketed vessel immersed in liquid air. Under these conditions they were exposed to a temperature of about — 250 ° C. (21° absolute) for ten hours. At the end of the experiment the tubes were opened, and the contents examined microscopically and by culture. The results were entirely negative as regards any alteration in appearance or in vigor of growth of the micro-organisms. It would appear, therefore, that an exposure for ten hours to a temperature of about — 250° C. has no appreciable effect on the vitality of micro-organisms. Dr. Macfadyen and Mr. Rowland hope in a future communication to extend their observation upon the influence of the temperature of liquid hydrogen on vital phenomena, and to discuss their bearing upon problems of vitality.

The new session of the Royal Geographical Society, London, as we learn from the London *Times*, began on November 12th, when it was expected that the president, Sir Clements Markham, would give a brief introductory address, to be followed by a paper by Dr. A. Donaldson Smith on his recent remarkable journey through Somaliland to Lake Rudolf, and across from Lake Rudolf to the Nile and home by Khartoum and Cairo. The second paper, on November 26th, will be by Mr. J. E. S. Moore, on his recent expedition for the scientific exploration of Lake Tanganyika and the interesting region to the north. At the meeting of December 10th Major Gibbons will give an account of his exploration of the Barotse country and his journey thence through Africa to the Mediterranean. After Christmas among the papers expected are one by Colonel G. E. Church, on the geography of South America, with special reference to its commercial development, and another on 'Further Studies in Wave Form,' by Mr. Vaughan Cornish. It is hoped that the Duke of the Abruzzi may be able to arrange to go to England some time next year before the end of the session and give the Society an account of his recent remarkable expedition towards the North Pole.

AT the opening of the new scientific laboratories at King's College, London, which took place on October 30th, Lord Lister made an address in which, according to the London *Times*, he said that it might seem strange that so large a gathering of distinguished men should come to witness the opening of certain laboratories. Yet the occasion was not unworthy of celebration, for it was an event of significance in regard to the provisions for higher education in the metropolis. It was recognized that mere lectures were not sufficient, that practical instruction was imperatively necessary. In some branches King's College was long ago well equipped to this end; the Wheatstone Museum contained a fine collection of physical apparatus, and in chemistry nothing could be better than the arrangements for practical teaching. The same might be said of other departments, but not of all. The dissecting room was by no means adequate, and the accommodation for the practical teaching of physiology was simply miserable, while there were defects in less degrees in other departments. Of these the Council had long been conscious, and, having determined to remedy them, had provided the new laboratories, which, as visitors would admit, were highly satisfactory. The laboratory for practical physiology in all its branches was now second to none in the country. It had really been in use for some time, and had attracted many students, not only from King's College, but from elsewhere. Its removal to the second floor gave room for the expansion of the anatomical department, and at the same time there had been provided a fine anatomical museum, which, however, was not yet equipped. The bacteriological laboratory had received an important addition. This laboratory, which owed its inception to Professor Crookshank, though it attracted advanced students not only from this country but from the world, had hitherto consisted of a single apartment which was not suitable for research work. For this latter purpose a new room had now been added, and a fine class-room had also been constructed, common to the professors of bacteriology and physiology. No doubt his audience had watched with interest, and rejoiced at the success of the endeavors made to check the outbreak of plague in Glasgow, and they must also have felt a sense of relief when the suspected case in the metropolis was found not to be plague; in both cases the means employed were entirely due to researches of the kind carried on in bacteriological laboratories. But it was not only the medical faculty of King's College that had benefited by the alterations. Geology now had accommodation proportionate to the importance of the subject, and in the architectural department there was abundant room for men engaged in drawing and designing. In short, King's College was abreast of the age as regards opportunities for practical teaching in all departments. It was a happy coincidence that this great addition to its resources had been made at the time when it was entering on a new career as one of the colleges of the new University of London. He himself would have liked to see the old examining university retained and a separate teaching university established. But other views prevailed, and a compromise had been effected under which examining and teaching existed side by side in the same institution. He wished the compromise all the success it was capable of, and ventured to express the hope that, now the matter was decided, all would work together for the common good.

UNIVERSITY AND EDUCATIONAL NEWS.

In addition to her recent gifts of $100,000 and $10,000 which we have recently announced, Mrs. Jane K. Sather, of Oakland, has presented to the University of California real estate worth $150,000.

Mr. William Waldorf Astor has contributed $50,000 to the benefaction fund of Cambridge University, England.

Columbia University has received a further anonymous gift of $10,000 for the purchase of books.

At the annual meeting of the Council of New York University it was reported that the gifts to the institution during the year had amounted to $348,000.

At a recent meeting of the Board of Trustees of Columbia University the committee on buildings and grounds was authorized to select a site and prepare plans for a college hall.

The main building of the Cornell University Veterinary College was partly burned on Tuesday. The apparatus destroyed was worth $10,000; the total loss is $30,000.

The Yale Forestry School has opened with an enrollment of seven regular students and seventeen from other departments of the University. The residence of the late Professor O. C. Marsh is used as a school building. In addition to lecture rooms, a library, laboratory and a herbarium room have been furnished with such equipment as is necessary for the present requirements of the school. A considerable amount of museum material has already been acquired by the school and is being classified and arranged as rapidly as possible. The grounds about the building, 10 acres, are already covered with a great variety of trees and shrubs, both native and foreign, and it is the intention to plant a considerable number of varieties which are not represented. A forest nursery will be established on the grounds, but the regular forest planting will be done on waste land on the outskirts of New Haven. The New Haven Water Company has offered to the school the use of several hundred acres of woodland for the practical field work of the students, and several other owners have expressed their desire to devote their wood-lots to this purpose. The degree of master of forestry will be given to such graduates of the school as have previously received the bachelor's degree from collegiate institutions of high standing.

A botanical school is being erected at a cost of $20,000 in Shealey Park, Pittsburg. It is intended especially for children in the schools, as it is believed that they can carry on the study of botany to greater advantage in a special laboratory than in the school-room.

Trinity College for the higher education of women, near the Catholic University at Washington, will be dedicated towards the end of the present month. Its educational work has already begun.

Mr. T. Nelson Dale, geologist of the U. S. Geological Survey, has resigned his instructorship in geology and botany at Williams College and his curatorship of the College Museum.

The following appointments have been made at Columbia University: W. W. Comstock, assistant in physics; Hardy Chambiss and W. E. Dryfus, assistants in chemistry; Charles E. Banker, assistant in normal histology, and Carlton P. Flint, assistant in demonstrative anatomy.

Mr. I. H. Derby, B.A. (Harvard, 1899), and F. C. Koch, M.A. (Illinois, 1900), have been appointed instructors in chemistry at the University of Illinois. At the same university, Mr. E. W. Ponzer, B.A. (Illinois, 1900), has been appointed instructor in mathematics.

Dr. Alfred L. T. Schaper, formerly assistant professor of histology at the Harvard Medical School, has been appointed professor extraordinary of anatomy, and director of the division for embryology and bio-mechanics at the University of Breslau.

Professor Georg Meissner, director of the Physiological Institute at Göttingen, will retire at the end of the present college term on account of ill health.

SCIENCE

Friday, November 23, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

GERMAN SCIENTIFIC APPARATUS.

To the Editor of Science: At the International Exposition, Paris, 1900, the jury having in charge Group III., Class 15, Instruments of Precision, Moneys and Medals, were very much impressed with the German exhibit. This exhibit was arranged in a different way from that used by any other nation. Germany made a joint exhibition of mechanicians and opticians, and arranged their apparatus in sections embracing certain classes of instruments, and thus departed from the usual custom of arranging the exhibits under various firms. This enabled the jury to see at once all instruments of the same kind grouped together in one case.

The German Association printed complete catalogues describing and illustrating the apparatus exhibited, and these catalogues and descriptions were of very great assistance to the jurors in making awards.

The catalogues printed an introduction, which gave in a very condensed form the history of the work done in Germany in improving the manufacture of instruments of precision. I enclose an English translation of this introduction furnished by the German Association, and suggest that it be published in full in Science, inasmuch as it shows by what methods the German mechanicians have been able to produce such splendid results.

J. K. Rees,
Member of the Jury, Group III., Class 15.

On this auspicious occasion, when the great French nation has invited the peoples of the world to inaugurate the 20th century by joining together under her hospitable sky in a brilliant exhibition of the works of peaceful competition, it would not seem irrelevant to glance back upon the departed century. It has been essentially an age of scientific and technical development and, naturally, the mechanical and optical trades claim a prominent share in the progress of mankind within the last hundred years. If we compare our present fundamental basis of all scientific measurements, our weights and measures, in their present perfection, with those existing a hundred years ago; if we place our finest astronomical and surveying instruments side by side with the to us almost primeval forms as they existed at the beginning of the century; or if we glance at our present sensitive physical and electrical measurements, remembering that a hundred years ago these were undreamt-of things, or in existence only in the crudest form, we cannot escape from a gladdening appreciation of the enormous progress made within the last century in the construction of philosophical instruments, as well as their reaction upon the progress of scientific investigations by dint of improved methods. A prominent share in this development of the aids of science is due to the German mechanicians and opticians.

At the commencement of the 19th century the French and English makers of scientific instruments were far in advance of the Germans. True, the 18th century knew of prominent mechanicians, and at the very beginning of the 19th century Fraunhofer and Reichenbach and their disciples, Repsold, of Hamburg, Pistor, of Berlin, and others, had secured general respect, in the scientific world, for German mechanical skill; yet the French and English makers took the lead at that time, so as to almost supply the world's entire demand in scientific instruments. This predominance had the further consequence of causing young Germans to emigrate to France or England in order to thoroughly master their subject. Many a German mechanician of the present day owes to French or English masters a substantial portion of his knowledge, and even in these days it is the aspiration of many a Teuton to widen his practical knowledge in France or England. The prominent position of the French and English instrument-makers was mainly due to the support which in both countries the State bestowed upon technical art. In England, the interests of the navy and merchant service gave rise to the assiduous development of astronomical and nautical measuring instruments, more particularly of astronomical chronometers, so as to ensure in these branches an absolute supremacy, which German mechanicians have only within the last ten or twenty years been able to contest. France owed her prominent position to the great geometrical survey of Cassini and his followers and, in a still greater degree, the admirable comprehensive labors leading to the establishment of the metrical system of weights and measures, which in its turn resulted in far-reaching improvements in the construction of appliances for weighing and measuring, astronomical and surveying, physical and chemical instruments.

In Germany, it is only within the last twenty or twenty-five years that the State has espoused the interests of the home industry in scientific instruments, but such have been the efforts and results that the position has, at a blow, as it were, changed in favor of Germany. Every possible encouragement was offered and great problems were created by the expenditure of the German governments, within the last thirty years, on art and science, the establishment of numerous large physical and chemical laboratories, the erection of new and the expansion of old observatories, the requisition of greatly improved surveying and astronomical instruments. Great progress resulted from the introduction of the metric system in the construction of exact weights and delicate balances, and, in compliance with the requirements of modern meteorology, led to vast improvements in thermometry and barometry. The development of the German navy created a great demand for nautical instruments. All these influences roused the productive powers of the nation and success has not been wanting.

Soon also the necessity was recognized of the close cooperation of the scientists and practical men. Accordingly, in 1879, several scientists, mechanicians and opticians united in Berlin and formed the nucleus of the German Association of Mechanicians and Opticians, which was formed in 1881 and embraced the whole German Empire, having for its object the scientific, technical and commercial development of philosophical instrument-making. The official organ of this Society, the *Zeitschrift für Instrumentenkunde*, was likewise founded in 1881 and is devoted to the theoretical and practical development of scientific instruments. Specialized schools were established, first in Berlin, then in Frankfort-on-the-Main and subsequently in many other towns, where savants and practical men are combined in training the rising generation in the theoretical departments of the subject. As a result of these serious scientific aims, German mechanicians and opticians sought in their laboratories and workshops the assistance of scientists, and at the present time the majority of the leading German firms retain one or more experienced mathematicians or physicists in their permanent service.

The greatest share of the impetus given to the manufacture of scientific instruments, however, is due to the Imperial Physical and Technical Institute, which was established in 1887. The first, or scientific, department of this important institution is devoted to purely physical research, whilst the second, or technical, department deals with matters concerning the construction of philosophical instruments. This institution has already done great service, and a large proportion of recent progress is due to its stimulating and helpful influence.

Seeing how comprehensive and systematic are the efforts brought to bear upon the art and science of instrument construction, it is not surprising that in this department Germany occupies now a foremost position. This fact was already apparent on the occasion of the Universal Exhibition of 1888 at Brussels, even more strikingly so at the World's Columbian Exhibition at Chicago in 1893, and remarkable achievements were shown by the combined members of the German Association of Mechanicians and Opticians at the Berlin Trades Exhibition of 1896.

After witnessing this steady development of our mechanical and optical trade, we cannot but look with confidence and gratification upon the practical demonstration at the Paris Centenary Exhibition of the flourishing state of the scientific instrument trade in Germany, and a characteristic feature of the latter is the unity of its aims, which is traceable to the history of its development and its intimate connection with pure science. It appeared, therefore, desirable to depart from the usual custom of grouping the exhibits under various firms, and rather to place them in sections embracing certain classes of instruments, so as to demonstrate on broad lines and as a whole, within a well-arranged though condensed area, the present position of German mechanical and optical art.

The Joint Exhibition of German Mechanicians and Opticians is, accordingly, subdivided into the following sections :

I. Metrological and Standardizing Instruments.
II. Astronomical Instruments.

III. Surveying and Nautical Instrnments: — a. Geometric Instruments, b. Surveying, Mining and exploring Instruments, c. Nautical Instruments.

IV. Meteorological, Geo-magnetic, Thermometric and Calorimetric Instruments.

V. Optical Instruments: —a. Photometrical Appliances ; b. Spectroscopes and Optical Measuring Instruments ; c. Microscopes and their auxiliaries ; d. Photomicrography and Projection ; e. Photographic Ojectives ; f. Hand Telescopes and Terrestrial Telescopes ; g. Crystaloptics, Appliances for demonstrating and observing the Phenomena of Light.

VI. Electrical Measuring Instruments for Scientific Purposes.

VII. Electro-medical, Physiological and Biological Instruments.

VIII. Appliances for Chemical and Chemico-physical Research, Laboratory and Educational Apparatns.

IX. Drawing and Calculating Appliances.

X. Appliances for the Examination of Materials and for Special Purposes, Special Tools and Anxiliaries.

Following the plan of grouping the exhibits into sections according to subjects of applied science, it may be profitable to append a short sketch of the present position of philosophical instrument-making in Germany.

I. German mechanicians found themselves for the first time in their history face to face with a task of some magnitude when called upon, some seventy years ago, to construct metrological and standardizing appliances for the purpose of determining, under the direction of the great astronomer Bessel, the standards of the old Prussian system of measures. Subsequently, the mechanical arts received an important impetus through the introduction of the metric system in general and the influence and requirements of the Standardizing Commission in particular. The numerous inducements and hints which German mechanicians have received from the Standardizing Commission have enabled them to effectually cooperate in the introduction of the metric system both in and outside Germany. Opportunities presented themselves for the construction of very exact comparators, dividing engines, terminal and divided measures, balances of the highest degree of precision, etc.; and while acquitting themselves of these tasks, German mechanicians have both learned and accomplished much. A considerable portion of the equipment of the 'Bureau international des poids et mesures' has proceeded from German workshops. The achievements of Germany in the department of metrological instruments and appliances are prominently demonstrated within the Joint Exhibition of Mechanicians and Opticians by the Special Exhibits of the Imperial Normal-Aichungs-Kommission [Office of Standards].

II. From the measures, the indispensable fundament of all exact research, we proceed to the astronomical instruments. This department is necessarily at a disadvantage inasmuch as the largest and most costly instruments, the large refractors, can only be exhibited under very special circumstances. Hitherto German telescope-makers have supplied large refractors almost exclusively to countries outside Germany, but in this respect they have actively competed with other makers. Recently they have been given an opportunity of proving their powers in the construction of the new Potsdam refractor, which is not only one of the largest instruments in Europe, but also the first large telescope built for a German observatory, and the results have been brilliant indeed. In the main, the German makers have devoted their attention to the construction of medium-sized and small astronomical instruments, refractors, transit-circles, altitude-circles, heliometers, etc., but with such success that, as regards the precision and delicacy of the individual parts of the instrument, Germany stands now unrivaled. Recently great progress has been made in the construction of astronomical objectives. The first optician who broke the ice in the important department of optical glass smelting was a German, to wit Fraunhofer. His untimely death was followed by a long period of stagnation, and the limits of the possible were soon reached when attempts were made to construct very large objectives, at least as far as the optician's art was concerned. About twenty years ago, Professor Abbe and Dr. Schott, of Jena, resumed the thread where Fraunhofer had left off, and they succeeded in producing the old crown and flint-glasses in such perfection that the chromatic differences of spherical aberration can be compensated almost completely. This led to great improvements in telescope lenses, and at the same time the Jena Glass Works have become so productive as to enable German opticians to cover their entire demand in Germany. Great progress has also been made in such an important branch of manufacture as that of spirit-levels. Not only are the finest spirit-levels incontestably made in Germany, but, in addition, the Imperal Physical and Technical Institute has successfully investigated the causes of the formation of deposits within the levels. Mechanicians possess now a ready means of detecting glass liable to deterioration and have no difficulty in securing suitable glasses.

III. The third section, comprising geometric and nautical instruments, includes also those instruments which form a connecting link between astronomy proper and the land-surveyor's art, *i. e.*, those astronomical instruments which are employed for geodetic measurements. Many improvements in this group of instruments have emanated from German workshops and have had their origin in the requirements of the International Survey and especially the influence of the Geodetic Institute and its present director, Dr. Helmert. We may here mention the conversion of the friction-rollers of transit instruments into a balance beam, so as to completely compensate the errors of collimation. We may also refer to Repsold's mode of fitting transit instruments so as to neutralize almost entirely the personal equation, and equally important are the improvements in zenith-telescopes and spirit-level testing appliances. The geophysical investigations of the International Survey have given birth to the most sensitive instrument of our times, the horizontal pendulum, which owes its origin and development to German scientists and mechanicians. The study of the movements of the oceans has recently been facilitated by greatly improved instruments, the most perfect of which are those of Seibt-Fuess. Remarkable progress has in late years been made in the construction of surveying instruments. The requirements of surveyors and engineers have reached such a high stage of development that they could not fail to beneficially affect the construction of theodolites, leveling instruments and tacheometers. The manufacture of surveying instruments is carried on in Germany on a very extensive scale, and the reputation of these instruments has obtained for them a wide market all over the world. Considerable improvements have also been made in small compactly built surveying instruments, which have been requisitioned by numerous German explorers. As the natural outcome of the developments of the merchant service and the creation of a powerful navy, considerable attention is paid to the manufacture of nautical instruments. Whereas formerly Germany depended for these accessories of navigation upon other countries, England in particular, at the present time all nautical instruments are manufactured at home equally well, in some respects even better than abroad.

IV. The development of the meteorological instruments and the appliances for measuring temperatures presents a typical illustration of the close connection between theoretical science and manufacture in Germany. This applies in particular to thermometers. About twenty years ago the manufacture of thermometers had come to a dead stop in Germany, thermometers being then invested with a defect, their liability to periodic changes, which seriously endangered German manufacture. Comprehensive investigations were then carried on by the Normal-Aichungs-Kommission, the Imperial Physical and Technical Institute and the Jena Glass Works, and after much labor brought the desired reward. Chemical analysis in conjunction with carefully managed glass smeltings and practical tests showed that pure potassic and pure sodic glasses possess these defects in the least degree, whereas glasses containing both alkalis are subject to periodic changes to such an extent as to render them useless for thermometric purposes. The last outcome of these investigations was the production, at the Jena Glass Works, of an excellent sodium glass which shows depressions of not more than 0.1° per 100°. Recently a boro-silicate glass has been prepared which shows a maximum depression of only 0.05° and possesses, moreover, the important property of excellently agreeing with the hydrogen thermometer. The advantages which may result from these discoveries to meteorology as well as the physical, chemical and medical sciences, are obvious. The technical arts too have benefited by discovery. With the aid of the new glasses and the invention of a process by which mercury is kept in the thermometer under a pressure of from 20 to 25 atmospheres, thermometers have been constructed for temperatures up to and beyond 550° C., as far as the region of incipient red heat, and reading accurately to $\frac{1}{10}$°. In consequence of these systematic efforts the manufacture of thermometers has reached in Germany an unprecedented level, and now governs the market of the world. German thermometers are purchased everywhere with particular confidence, as they can be supplied with official certificates. The Thermometer Testing Institute of Ilmenau examine annually about 40,000, and 16,000 are annually tested by the Imperial Physical and Technical Institute. German barometers, mercurial as well as aneroid, enjoy a high reputation and are everywhere esteemed for their delicate workmanship and reliability. The aneroid-barometers, which have obtained increased importance through the requirements of explorers, are tested by the Imperial Physical and Technical Institute with respect to their liability to periodic changes. The merits of the German self-registering instruments of the Sprung-Fuess type, thermographs and barographs, anemometers and rain-gauges are so well known that they need no further comment. These excellent instruments are used in all the meteorological observatories of the world. Finally, attention should be drawn to the pyrometers and calorimeters, which have also been considerably improved in recent years.

V. Like the mechanical arts, optical construction has made great and rapid progress in Germany. In this connection it is our gratifying duty to mention the name of Abbe, whose master-mind has had a profound influence upon the development of German optical science and manufacture. Abbe's earliest great merit is the elucidation of the theory of the microscope, by which he has placed microscopical optics upon an entirely new basis. It is also due to his efforts, in conjunction with those of Dr. Schott, the head of the Jena Glass Works, that numerous optically valuable glasses have been rendered available for the purposes of optical construction and that many difficult problems have now been solved. The new Jena phosphate and baryte glasses have led to many improvements in microscopical optics. We need only refer to the

Zeiss Apochromatic objectives, which, in conjunction with the compensating eyepieces, yield a much more perfect correction of the chromatic and spherical aberrations than was previously attainable. We believe that we are not going too far by saying that to Professor Abbe is due the world-wide fame of German microscope construction. This reputation is not limited to the microscope itself, but to all its accessories, and embraces also microtomes, photo-micrographic and projection appliances and, in particular, photographic objectives, the construction of which has undergone wonderful changes since the introduction of the Jena glasses. The enormous exigencies of modern artificial illumination has given rise to many improvements in photometry. In this department the path has been smoothed by the efforts of the Imperial Physical and Technical Institute, and photometers are now made by which the intensity of a luminary can be measured with a degree of accuracy within ½ per cent. The result is that German photometers enjoy a predominant popularity.—Germany, the cradle of spectrum analysis, occupies naturally an important position in the manufacture of spectrum appliances. The construction of these instruments, varying from the largest and finest spectrometers for astronomical, physical and chemical research, to the smallest hand spectroscopes, employs a large number of establishments. The same applies to the manufacture of polariscopic appliances, which have a wide reputation and command a particularly large market in the sugar trade.—No less importance attaches to the optical measuring instruments designed for the special requirements of physicists, chemists, mineralogists, etc., which are made with astronomical precision, so as to satisfy the highest exigencies of modern research. Among these we may mention the crystaloptic instruments and those for studying the theory of the nature of light.—In the construction of telescopes Germany has, in addition to general improvements, achieved a triumph, which has given her a great advantage. We are referring to the new form of binocular telescopes, in which, by the interposition of prisms, the dimensions of terrestrial telescopes are reduced to their lowest limits, while, at the same time, the defining power, light-gathering power and the stereoscopic effect are greatly increased as compared with the old types. The invention of these telescopes has created a wide demand in the army and navy. Very considerable, too, is the industry in optical auxiliaries, prisms, quartz and calc-spar preparations, etc., in which Germany excels both in quality and productiveness.

VI. The manufacture of electrical measuring instruments for scientific purposes has, in Germany, kept pace with the great strides made in electrical engineering. A number of prominent firms apply themselves to this technical branch and have made themselves a good name. This industry has likewise profited by the fundamental labors of the Imperial Physical and Technical Institute, in particular by the establishment of standards and by important investigations. We may here mention the introduction of new resistance materials, called manganine and constantan, which are not affected by changes of temperature and are now introduced by nearly all German firms occupied with the manufacture of electrical measuring instruments. Mention should also be made of the work accomplished in standard cells, which facilitate the application of the so-called methods of compensation for accurately measuring the strength and E.M.F. of electrical currents. This is, therefore, another department where the influence of scientific research has been felt in practical manufacture.

VII. Electro-medical appliances are also made in Germany and exported abroad in very large numbers. The growing application of the electric current as a curative agent in operations and for the illumination of internal cavities of the human body has caused this department of industry to develop considerably both technically and commercially. To this group of appliances belong the various kinds of Röntgen ray apparatus, which are made and exported in stupendous numbers. Great importance attaches also to the manufacture of physiological and biological instruments, which engages the attention of several prominent firms.

VIII. The manufacture of educational appliances has grown in proportion to the development of the methods of practical demonstration in elementary as well as intermediate schools and technical colleges. The German output of educational appliances has at present reached a truly astounding magnitude. This is mainly due to their cheapness, simplicity and their suitable size. The laboratory appliances required for scientific investigations comprise naturally the finest and costliest instruments made.

IX. The manufacture of drawing and calculating instruments employs a large number of German mechanicians. Excellent drawing instruments and other appliances for drawing, cartography, etc., are exported to all parts of the world. German mechanicians have likewise succeeded in considerably improving Thomas's old calculating machine.

X. In addition to purely scientific instruments, a very large number of appliances are in constant requisition for special industrial purposes, and many a mechanician finds constant employment in this department. Besides, much thought and skill is brought to bear upon the needs of mechanical workshops. Formerly every mechanician made his own tools, and in many instances this is still done. Many changes have, however, been wrought in this respect by the influence of the American system of manufacture, in which, it should be added, Germans have a considerable share. Prominent mechanicians and engineers began to devote themselves more or less exclusively to the manufacture of special tools for philosophical instrument-making, and now form an important independent branch of industry.

In conclusion, we have to draw attention to the separate exhibition of the Imperial Physical and Technical Institute, which could not be mortised into the general plan of the Joint Exhibition. The aims of this Institute, the greatest of its kind in the world, have already been explained. The exhibits of the Institute serve to illustrate in a concise form several spheres of its activity.

The commercial importance of the mechanical and optical trade of Germany is commensurate with its reputation, as will readily be seen from the following table showing the export of scientific instruments during 1898:

	Net weight kilos.	Value in Marks.
Astronomical, optical mathematical, physical and electrical instruments	218,900	8,975,000
Raw optical glass (flint and crown)	124,900	625,000
Optical glasses (spectacles, reading-glasses, stereoscope glasses)	224,200	3,139,000
Terrestrial telescopes, field-glasses, opera-glasses, m'ntd spectacles, etc	33,900	1,526,000
Total	601,900	14,265,000

The export has been trebled within ten years!

Another measure of the magnitude of the mechanical and optical trade of Germany may be obtained from the number of manufacturing establishments and their employés.

These are at present as follows:

Nature of manufacture.	Number of establishments.	Number of persons employed.
Astronomical, optical, mathematical, physical and electrical instruments..............	500	9,200
Glass-blowing, glass instruments, glass thermometers...	125	1,773
Optical instruments, spectacles, reading-glasses............	165	2,652
Total................	790	13,625

THE FIRST SPECIES NAMED AS THE TYPE OF THE GENUS.

IN the suggestive article on 'The Method of Types in Botanical Nomenclature,' by Mr. O. F. Cook, published in SCIENCE of September 28, 1900, is an admirable statement of the meaning of type in biological taxonomy.

A species 'is a coherent or continuous group of organisms.' Its type is the first individual on which the specific name was bestowed. The type-specimen has an especial value in fixing the name and meaning of the species.

In like manner 'a genus of organisms is a species without close affinities or a group of mutually related species.' In other words, it too 'is a coherent or continuous group of organisms.' It is essential to its definition that some one of its species should constitute its type, to which the generic name should be inseparably attached. The large genera of earlier writers, subdivisions of their artificial orders, rather than groups of species, must become each associated around a special type before they can enter into modern conceptions of nomenclature.

The first essential in nomenclature is fixity. To establish permanence we must eliminate all elements of personal choice. The fixity of specific names through the law of priority is now fairly well established. Generic names are not yet similarly fixed. The method of changing the conception of an old genus from that of a mere subdivision of a higher group to that of a group of related species associated about a type species has not yet been well determined. In nomenclature, a genus must be fixed by its type, which is definite, not by its definition, which may be amended. Some writers have insisted that the first writer who subdivides a genus has the right and the duty to fix its type. Others maintain that the type must always be fixed by the process of elimination. In this process authors who eliminated unconsciously or in ignorance must be considered, as well as those who attempted to limit and define the generic parts in a group of family rank, called by its author a genus.

The method of elimination is now generally approved, but there is great variation in the application of it. Its great defect lies in the necessary uncertainty of its definition. Too often different assumptions or different points of view give different results. Any result may be vitiated by the discovery of some note or discussion—useless in itself, which may have been overlooked at the time of the first attempt at finding the type.

Inasmuch as the thought of type is inseparable in modern taxonomy from the idea of genus or species, it is most desirable to find some way of fixing the type of an author through the words of the author himself—not trusting to the mazes of subsequent delimitation and elimination.

The most convenient and most logical method of doing this, as well as the one most practically convenient, is to fix a group name to the first individual or the first species to which the name was tenably applied. If based on specimens, the species would rest with the individual actually in hand for description. If based on a series of previous records, the one of these standing first in the list of synonyms should be the type.

In the case of the genus, if no type, central species or 'chef de file' is indicated by the author, the first species referred to the genus by the author or by any subsequent writer ought to be taken as the type. This would ensure fixity. It has no element of injustice.. The genus should stand or fall on the first species mentioned.

As Mr. Cook observes: "The selection of the first species as the type would result in no complications by reason of the Linnæan arrangement of species, and it may be confidently expected that the uniform application of such a rule would necessitate far fewer changes than would the method of elimination whereby the doubtful or unidentifiable species are often the only residue on which time-honored names could be maintained."

The practicability of this rule must be tested by different taxonomists, each by its effects in his own field of work. In ichthyology it would bring an enormous gain in giving fixity of generic nomenclature which can be attained in no other way. The process of elimination has never been consistently followed, nor can the process be so defined that it can yield fixed results in the case of the complex genera of the last century. The practice of taking the first species named as the generic type has been adopted and continuously followed by the most voluminous writer on fishes, Dr. Pieter van Bleeker, and others have used it as a guide in cases of doubt.

The really strong and perhaps conclusive argument against it is derived from its effect on the genera of Linnæus. In general, Linnæus placed his central species or type in the midst of a genus, leaving the aberrant species at either end of the list. Cuvier followed the plan of giving a full description of a type species or 'chef de file,' letting the less known or less important species follow after it. It was not until about the beginning of the nineteenth century that the thought of a type species came to be associated with the genus.

Should we adopt the 'first species type' rule in relation to genera, the following changes would result from its application to the tenth edition of the Systema Naturæ.

Raja would be transferred to *Tetronarce* (Torpedo).
Squalus would remain with *Acanthias*.
Gadus would replace *Melanogrammus*.
Echeneis would replace *Remora*.
Cottus would replace *Agonus*.
Zeus would replace *Selene*.
Pleuronectes would replace *Achirus*.
Chætodon would replace *Zanclus*.
Labrus would replace *Sparisoma*.
Trigla would replace *Peristethus*.
Cobitis would replace *Anableps*.
Silurus would replace *Parasilurus*.
Esox would replace *Spyræna*.
Polynemus would replace *Pentanemus*.
Cyprinus would replace *Barbus*.
Ostracion would replace *Lactophrys*.
Tetraodon would replace *Spheroides*.
Diodon would replace *Chilomycterus*.
Syngnathus would replace *Typhle*.
Muræna, *Blennius*, *Gobius*, *Sparus*, *Sciæna*, *Perca*, *Gasterosteus*, *Salmo*, and *Clupea* would be unchanged.

These changes in time-honored names are apparently out of the question. In ichthyology the rule, if adopted, must pass by Linnæus to take effect with his successors or perhaps only among writers of this century influenced by the Cuvierian 'chef de file' method or by the modern conception of type.

The possibility of this suggestion is worth considering. It is stated on high authority, though I have not yet verified the quotation, that Linnæus somewhere says in effect that the real type of each genus recognized by him is 'the best known European or officinal species contained in it.' It would be relatively easy to determine the species worthy of this distinction. It would be easy to put ourselves in Linnæus' place in this regard. Then taking the Systema Naturæ as a starting point, it would be possible and just to hold each genus of each author, where no type is explicitly indicated, rigidly to the first species named under it. By this ruling it would be possible to avoid certain very undesirable changes in Linnæan nomenclature, unavoidable under the rule of elimination. Among these are the following:

Esox for *Belone*.
Syngnathus for *Nerophis*.
Polynemus for *Pentanemus*.

Meanwhile the confused generic messes of Bloch, Lacépède, Swainson, Rafinesque and others, could be definitely crystallized and made to stand or fall on the generic distinction of the first species named.

The general adoption of such means of determining types would go a long way toward stability of nomenclature, and it is possible to use it in case we may be permitted to apply another method to the genera of Linnæus. If no exceptions can be properly made, then, for one, the writer would prefer its rigid application to all authors, Linnæus included, to the present state of confusion.

In any event, the suggestion of Mr. Cook merits serious consideration and reconsideration, for it has been several times rejected by zoologists.

DAVID STARR JORDAN.

ADDRESS OF THE PRESIDENT OF THE SECTION OF GEOLOGY OF THE BRITISH ASSOCIATION.

II.

OBSCURE CHAPTER IN THE EARTH'S HISTORY.

BEFORE discussing the validity of the argument on which this last result depends, let us consider how far it harmonizes with previous ones. It is consistent with Lord Kelvin's and Professor Darwin's, but how does it accord with Professor Joly's? Supposing we reduce his estimate to fifty-five millions; what was the earth doing during the interval between the period of fifty-five millions of years ago and that of only twenty-six and one-half millions of years ago, when, it is presumed, sedimentary rocks commenced to be formed? Hitherto we have been able to reason on probabilities; now we enter the dreary region of possibilities, and open that obscure chapter in the history of the earth previously hinted at. For there are many possible answers to this question. In the first place, the evidence of the stratified rocks may have been wrongly interpreted, and two or three times the amount of time we have demanded may have been consumed in their formation. This is a very obvious possibility, yet again our estimate concerning these rocks may be correct, but we may have erroneously omitted to take into account certain portions of the Archæan complex, which may represent primitive sedimentary rocks formed under exceptional conditions, and subsequently transformed under the influence of the internal heat of the earth. This, I think, would be Professor Bonney's view. Finally, Lord Kelvin has argued that the life of the sun as a luminous star is even more briefly limited than that of our oceans. In such a case, if our oceans were formed fifty-five millions of years ago, it is possible that after a short existence as almost boiling water they grew colder and colder, till they became covered with thick ice, and moved only in obedience to the tides. The earth, frozen and dark, except for the red glow of her volcanoes, waited the coming of the sun, and it was not till his growing splendor had banished the long night that the cheerful sound of running waters was heard again in our midst. Then the work of denudation and deposition seriously recommenced, not to cease till the life of the sun is spent. Thus the thickness of the stratified series may be a measure rather of the duration of sunlight than of the period which has elapsed since the first formation of the ocean. It may have been so—we cannot tell—but it may be fairly urged that we know less of the origin, history, and constitution of the sun than of the earth itself, and that, for aught we can say to the contrary, the sun may have been shining on the just-formed ocean as cheerfully as he shines to-day.

TIME REQUIRED FOR THE EVOLUTION OF THE LIVING WORLD.

But, it will be asked, how far does a period of twenty-six millions satisfy the demands of biology? Speaking only for myself, although I am aware that eminent biologists are not wanting who share this opinion, I answer, Amply. But, it will be exclaimed, surely there are 'comparisons in things.' Look at Egypt, where more than 4,000 years since the same species of man and animals lived and flourished as to-day. Examine the frescoes and study the living procession of familiar forms they so faithfully portray, and then tell us, how comes it about that from changes so slow as to be inappreciable in the lapse of forty centuries you propose to build up the whole organic world in the course of a mere twenty-six millions of years? To all which we might reply that even changeless Egypt presents us with at least one change—the features of the ruling race are to-day not quite the same as those of the Pharaohs. But putting this on one side, the admitted constancy in some few common forms proves very little, for so long as the environment remains the same natural selection will conserve the type, and, so far as we are able to judge, conditions in Egypt have remained remarkably constant for a long period.

Change the conditions, and the resulting modification of the species becomes manifest enough; and in this connection it is only necessary to recall the remarkable mutations observed and recorded by Professor Weldon in the case of the crabs in Plymouth Harbor. In response to increasing turbidity of the sea water these crabs have undergone or are undergoing a change in the relative dimensions of the carapace, which is persistent, in one direction, and rapid enough to be determined by measurements made at intervals of a few years.

Again, animals do not all change their characters at the same rate: some are stable, in spite of changing conditions, and these have been cited to prove that none of the periods we look upon as probable, not twenty-five, not a hundred millions of years, scarce any period short of eternity, is sufficient to account for the evolution of the living world. If the little tongue-shell, *Lingula*, has endured with next to no perceptible change from the Cambrian down to the present day, how long, it is sometimes inquired, would it require for the evolution of the rest of the animal kingdom? The reply is simple: the cases are dissimilar, and the same record which assures us of the persistency of the *Lingula* tells us in language equally emphatic of the course of evolution which has led from the lower organisms upwards to man. In recent and Pleistocene deposits the relics of man are plentiful: in the latest Pliocene they have disappeared, and we encounter the remarkable form *Pithecanthropus;* as we descend into the Tertiary systems the higher mammals are met with, always sinking lower and lower in the scale of organization as they occur deeper in the series, till in the Mesozoic deposits they have entirely disappeared, and their place is taken by the lower mammals, a feeble folk, offering little promise of the future they were to inherit. Still lower, and even these are gone; and in the Permian we encounter reptiles and the ancestors of reptiles, probably ancestors of mammals too; then into the Carboniferous, where we find amphibians, but no true reptiles; and next into the Devonian, where fish predominate, after making their earliest appearance at the close of the Silurian times; thence downwards, and the vertebrata are no more found—we trace the evolution of the invertebrata alone. Thus the orderly procession of organic forms follows in precisely the true phylogenetic sequence; invertebrata first, then vertebrata, at first fish, then amphibia, next reptiles, soon after mammals, of the lowlier kinds first, of the higher later, and these in increasing complexity of structure till we finally arrive at man himself. While the living world was thus unfolding into new and nobler forms, the immutable *Lingula* simply perpetuated its kind. To select it, or other species equally sluggish, as the sole measure of the rate of biologic change would seem as strange a proceeding as to confound the swiftness of a river with the stagnation of the pools that lie beside its banks. It is occasionally objected that the story we have drawn from the paleontological record is mere myth or is founded only on negative evidence. Cavils of this kind prove a double misapprehension, partly as to the facts, partly as to the value of negative evidence, which may be as good in its way as any other kind of evidence.

Geologists are not unaware of the pitfalls which beset negative evidence, and they do not conclude from the absence of fossils in the rocks which underlie the Cambrian that pre-Cambrian periods were devoid of life; on the contrary, they are fully persuaded that the seas of those times were teeming with a rich variety of invertebrate forms. How is it that, with the exception of some few species found in beds immediately underlying the Cambrian, these have left behind no vestige of their existence? The explanation does not lie in the nature of the sediments, which are not unfitted for the preservation of fossils, nor in the composition of the then existing sea water, which may have contained quite as much calcium carbonate as occurs in our present oceans; and the only plausible supposition would appear to be that the organisms of that time had not passed beyond the stage now represented by the larvæ of existing invertebrata, and consequently were either unprovided with skeletons, or at all events with skeletons durable enough for preservation. If so, the history of the earlier stages of the evolution of the invertebrata will receive no light from paleontology and no direct answer can be expected to the question whether, eighteen or nineteen millions of years being taken as sufficient for the evolution of the vertebrata, the remaining available eight millions would provide for that of the invertebrate classes which are represented in the lowest Cambrian deposits. On *à priori* grounds there would appear to be no reason why it should not. If two millions of years afforded time enough for the conversion of fish into amphibians, a similar period should suffice for the evolution of trilobites from annelids, or of annelids from trochospheres. The step from gastrulas to trochospheres might be accomplished in another two millions, and two millions more would take us from gastrulas through morulas to protozoa.

As things stand, biologists can have nothing to say either for or against such a conclusion; they are not at present in a position to offer independent evidence; nor can they hope to be so until they have vastly extended those promising investigations which they are only now beginning to make into the rate of the variation of species.

UNEXPECTED ABSENCE OF THERMAL METAMORPHOSIS IN ANCIENT ROCKS.

Two difficulties now remain for discussion: one based on theories of mountain chains, the other on the unaltered state of some ancient sediments. The latter may be taken first. Professor van Hise writes as follows regarding the pre-Cambrian rocks of the Lake Superior district: "The Penokee series furnishes an instructive lesson as to the depth to which rocks may be buried and yet remain but slightly affected by metamorphosis. The series itself is 14,000 feet thick. It was covered before being upturned with a great thickness of Keweenaw rock. This series of the Montreal River is estimated to be 50,000 feet thick. Adding to this the known thickness of the Penokee series, we have a thickness of 64,000 feet. * * * The Penokee rocks were then buried to a great depth, the exact amount depending upon their horizon and upon the stage in Keweenaw time, when the tilting and erosion, which brought them to the surface, commenced.

"That the synclinal trough of Lake Superior began to form before the end of the Keweenaw period, and consequently that the Penokee rocks were not buried under the full succession, is more than probable. However, they must have been buried to a great depth—at least several miles—and thus subjected to high pressure and temperature, notwithstanding which they are comparatively unaltered." *

I select this example because it is one of the best instances of a difficulty that occurs more than once in considering the history of sedimentary rocks. On the supposition that the rate of increment of temperature with descent is 1° F. for every 84 feet, or 1° C. for every 150 feet, and that it was no greater during these early Penokee times, then at a depth of 50,000 feet the Penokee rocks would attain a temperature of nearly 333° C.; and since water begins to exert powerful chemical action at 180° C. they should, on the theory of a solid cooling globe, have suffered a metamorphosis sufficient to obscure their resemblance to sedimentary rocks. Either then the accepted rate of downward increase of temperature is erroneous, or the Penokee rocks were never depressed, in the place where they are exposed to observation, to a depth of 50,000 feet. Let us consider each alternative, and in the first place let us apply the rate of temperature increment determined by Professor Agassiz in this very Lake Superior district: it is 1° C. for every 402 feet, and twenty-five millions of years ago, or about the time when we may suppose the Penokee rocks were being formed, it would be 1° C. for every 305.5 feet, with a resulting temperature, at a depth of 50,000 feet, of 163° C. only. Thus the admission of a very low rate of temperature increment would meet the difficulty; but on the other hand, it would involve a period of several hundreds of millions of years for the age of the 'consistentior status,' and thus greatly exceed Professor Joly's maximum estimate of the age of the oceans. We may therefore turn to the second alternative. As regards this, it is by no means certain that the exposed portion of the Penokee series ever was depressed 50,000 feet; the beds lie in a synclinal the base of which indeed may have sunk to this extent, and entered a region of metamorphosis; but the only part of the system that lies exposed to view is the upturned margin of the synclinal, and as to this it would seem impossible to make any positive assertion as to the depth to which it may or may not have been depressed. To keep an open mind on the question seems our only course for the present, but difficulties like this offer a promising field for investigation.

**Tenth Annual Report U. S. Geol. Survey*, 1888–89, p. 457.

THE FORMATION OF MOUNTAIN RANGES.

It is frequently alleged that mountain chains cannot be explained on the hypothesis of a solid earth cooling under the conditions and for the period we have supposed. This is a question well worthy of consideration, and we may first endeavor to picture to ourselves the conditions under which mountain chains arise. The floor of the ocean lies at an average depth of 2,000 fathoms below the land, and is maintained at a constant temperature, closely approaching 0° C., by the passage over it of cold water creeping from the polar regions. The average temperature of the surface of the land is above zero, but we can afford to disregard the difference in temperature between it and the ocean floor, and may take them both at zero. Consider next the increase of temperature with descent, which occurs beneath the continents: at a depth of 13,000 feet, or at same depth as the ocean floor, a temperature of 87° C. will be reached on the supposition that the rate of increase is 1° C. for 150 feet, while with the usually accepted rate of 1° C. for 108 feet it would be 120° C. But at this depth the ocean floor, which is on the same spherical surface, is at 0° C. Thus surfaces of equal temperature within the earth's crust will not be spherical, but will rise or fall beneath an imaginary spherical or spheroidal surface, according as they occur beneath the continents or the oceans. No doubt at some depth within the earth the departure of isothermal surfaces from a spheroidal form will disappear; but considering the great breadth both of continents and oceans, this depth must be considerable, possibly even forty or fifty miles. Thus the subcontinental excess of temperature may make itself felt in regions where the rocks still retain a high temperature, and are probably not far removed from the critical fusion point. The effect will be to render the continents mobile as regards the ocean floor; or *vice versa*, the ocean floor will be stable compared with the continental masses. Next it may be observed that the continents pass into the bed of the ocean by a somewhat rapid flexure, and that it is over this area of flexure that the sediments denuded from the land are deposited. Under its load of sediment the sea floor sinks down, subsiding slowly, at about the same rate as the thickness of sediment increases; and whether as a consequence or a cause, or both, the flexure marking the boundary of land and sea becomes more pronounced. A compensating movement occurs within the earth's crust, and solid material may flow from under the subsiding area in the direction of least resistance, possibly towards the land. At length, when some thirty or forty thousand feet of sediment have accumulated in a basin-like form, or, according to our reckoning, after the lapse of three or four millions of years, the downward movement ceases, and the mass of sediment is subjected to powerful lateral compression, which, bringing its borders into closer proximity by some ten or thirty miles, causes it to rise in great folds high into the air as a mountain chain.

It is this last phase in the history of mountain making which has given geologists more cause for painful thought than probably any other branch of their subject, not excluding even the age of the earth. It was at first imagined that during the flow of time the interior of the earth lost so much heat, and suffered so much contraction in consequence, that the exterior, in adapting itself to the shrunken body, was compelled to fit it like a wrinkled garment. This theory, indeed, enjoyed a happy existence till it fell into the hands of mathematicians, when it fared very badly, and now lies in a pitiable condition neglected of its friends.*

For it seemed proved to demonstration that the contraction consequent on cooling was wholly, even ridiculously, inadequate to explain the wrinkling. But when we summon up courage to inquire into the data on which the mathematical arguments are based, we find that they include several assumptions, the truth of which is by no means self-evident. Thus it has been assumed that the rate at which the fusion point rises with increased pressure is constant, and follows the same law as is deduced

* With some exceptions, notably Mr. C. Davison, a consistent supporter of the theory of contraction.

from experiments made under such pressures as we can command in our laboratories down to the very center of the earth, where the pressures are of an altogether different order of magnitude; so with a still more important coefficient, that of expansion, our knowledge of this quantity is founded on the behavior of rocks heated under ordinary atmospheric pressure, and it is assumed that the same coefficient as is thus obtained may be safely applied to material which is kept solid, possibly near the critical point, under the tremendous pressure of the depths of the crust. To this last assumption we owe the terrible bogies that have been conjured out of 'the level of no strain.' The depth of this, as calculated by the Rev. O. Fisher, is so trifling that it would be passed through by all very deep mines. Mr. C. Davison, however, has shown that it will lie considerably deeper, if the known increase of the coefficient of expansion with rise of temperature be taken into account. It is possible, it is even likely, that the coefficient of expansion becomes vastly greater when regions are entered where the rocks are compelled into the solid state by pressure. So little do we actually know of the behavior of rock under these conditions that the geologist would seem to be left very much to his own devices; but it would seem there is one temptation he must resist—he must not take refuge in the hypothesis of a liquid interior.

We shall boldly assume that the contraction at some unknown depth in the interior of the earth is sufficient to afford the explanation we seek. The course of events may then proceed as follows: The contraction of the interior of the earth, consequent on its loss of heat, causes the crust to fall upon it in folds, which rise over the continents and sink under the oceans, and the flexure of the area of sedimentation is partly a consequence of this folding, partly of overloading. By the time a depression of some 30,000 or 40,000 feet has occurred along the ocean border the relation between continents and oceans has become unstable, and readjustment takes place, probably by a giving way of the continents, and chiefly along the zone of greatest weakness—*i. e.*, the area of sedimentation, which thus becomes the zone of mountain building. It may be observed that at great depths readjustment will be produced by a slow flowing of solid rock, and it is only comparatively near the surface, five or ten miles at the most below, that failure of support can lead to sudden fracture and collapse; hence the comparatively superficial origin of earthquakes.

Given a sufficiently large coefficient of expansion—and there is much to suggest its existence — and all the phenomena of mountain ranges become explicable; they began to present an appearance that invites mathematical treatment; they inspire us with the hope that from a knowledge of the height and dimensions of a continent and its relations to the bordering ocean we may be able to predict when and where a mountain chain should arise, and the theory which explains them promises to guide us to an interpretation of those world-wide unconformities which Suess can only account for by a transgression of the sea. Finally it relieves us of the difficulty presented by mountain formation in regard to the estimated duration of geological time.

INFLUENCE OF VARIATIONS IN THE ECCENTRICITY OF THE EARTH'S ORBIT.

This may perhaps be the place to notice a highly interesting speculation which we owe to Professor Blytt, who has attempted to establish a connection between periods of readjustment of the earth's crust and variations in the eccentricity of the earth's orbit. Without entering into any discussion of Professor Blytt's methods, we may offer a comparison of his results with those that follow from our rough estimate of one foot of sediment accumulated in a century.

TABLE SHOWING THE TIME THAT HAS ELAPSED SINCE THE BEGINNING OF THE SYSTEMS IN THE FIRST COLUMN, AS RECKONED FROM THICKNESS OF SEDIMENT IN THE SECOND COLUMN, AND BY PROFESSOR BLYTT IN THE THIRD.

	Years.	Years.
Eocene	4,200,000	3,250,000
Oliogocene	3,000,000	1,810,000
Miocene	1,800,000	1,160,000
Pliocene	900,000	700,000
Pleistocene	400,000	350,000

It is now time to return to the task, too long postponed, of discussing the data from which we have been led to conclude that a probable rate at which the sediments have accumulated in places where they attain their maximum thickness is one foot per century.

RATE OF DEPOSITION OF SEDIMENT.

We owe to Sir Archibald Geikie a most instructive method of estimating the existing rate at which our continents and islands are being washed into the sea by the action of rain and rivers: by this we find that the present land surface is being reduced in height to the extent of an average of 1/2400 foot yearly (according to Professor Penck 1/3600 foot). If the material removed from the land were uniformly distributed over an area equal to that from which it had been derived it would form a layer of rock 1/2400 foot thick yearly—*i. e.*, the rates of denudation and deposition would be identical. But the two areas, that of denudation and that of deposition, are seldom or never equal, the latter, as a rule, being much the smaller. Thus the area of that part of North America which drains into the Gulf of Mexico measures 1,800,000 square miles; the area over which its sediments are deposited is, so far as I can gather from Professor Agassiz's statements, less then 180,000 square miles; while Mr. McGee estimates it at only 100,000 square miles. Using the largest number, the area of deposition is found to measure one-tenth the area of denudation; the average rate of deposition will therefore be ten times as great as the rate of denudation, or 1/240 foot may be supposed to be uniformly distributed over the area of sedimentation in the course of a year. But the thickness by which we have measured the strata of our geological systems is not an average, but a maximum thickness; we have therefore to obtain an estimate of the maximum rate of deposition. If we assume the deposited sediments to be arranged somewhat after the fashion of a wedge with the thin end seawards, then twice the average would give us the maximum rate of deposition; this would be one foot in 120 years. But the sheets of deposited sediment are not merely thicker towards the land, thinner towards the sea, they also increase in thickness towards the rivers in which they have their source, so that a very obtuse-angled cone, or, better, the downturned bowl of a spoon, would more nearly represent their form. This form tends to disappear under the action of waves and currents, but a limit is set to this disturbing influence by the subsidence which marks the region opposite tho mouth of a large river. By this the strata are gradually let downwards, so that they come to assume the form of the bowl of a spoon turned upwards. Thus a further correction is necessary if we are to arrive at a fair estimate of the maximum rate of deposition. Considering the very rapid rate at which our ancient systems diminish in thickness when traced in all directions from the localities where they attain their maximum, it would appear that this correction must be a large one. If we reduce our already corrected estimate by one-fifth, we arrive at a rate of one foot of sediment deposited in a century.

No doubt this value is often exceeded; thus in the case of the Mississippi River the bar of the southwest pass advanced between the years 1838 and 1874 a distance of over two miles, covering an area 2.2 miles in width with a deposit of sediment 80 feet in thickness; outside the bar, where the sea is 250 feet in depth, sediment accumulates, according to Messrs. Humphreys and Abbot, at a rate of two feet yearly. It is quite possible, indeed it is very likely, that some of our ancient strata have been formed with corresponding rapidity. No gravel of coarse sand is deposited over the Mississippi delta; such material is not carried further seawards than New Orleans. Thus the vast sheets of conglomerate and sandstone which contribute so largely to some of our ancient systems, such as the Cambrian, Old Red Sandstone, Millstone Grit, and Coal Measures, must have accumulated under very different conditions, conditions for which it is not easy to find a parallel; but in any case these deposits afford evidence of very rapid accumulation.

These considerations will not tempt us, however, to modify our estimate of one foot in a century; for though in some cases this rate may have been exceeded, in others it may not have been nearly attained.

Closely connected with the rate of deposition is that of the changing level of land and sea; in some cases, as in the Wealden delta, subsidence and deposition appear to have proceeded with equal steps, so that we might regard them as transposable terms. It would therefore prove of great assistance if we could determine the average rate at which movements of the ground are proceeding; it might naturally be expected that the accurate records kept by tidal gauges in various parts of the world would afford us some information on this subject; and no doubt they would, were it not for the singular misbehavior of the sea, which does not maintain a constant level, its fluctuations being due, according to Professor Darwin, to the irregular melting of ice in the polar regions. Of more immediate application are the results of Herr L. Holmström's observations in Scandinavia, which prove an average rise of the peninsula at the rate of three feet in a century to be still in progress; and Mr. G. K. Gilbert's measurements in the Great Lake district of North America, which indicate a tilting of the continent at the rate of three inches per hundred miles per century. But while measurements like these may furnish us with some notion of the sort of speed of these changes, they are not sufficient even to suggest an average; for this we must be content to wait till sufficient tidal observations have accumulated and the disturbing effect of the inconstancy of the sea level eliminated.

It may be objected that in framing our estimate we have taken into account mechanical sediments only, and ignored others of equal importance, such as limestone and coal. With regard to limestone, its thickness in regions where systems attain their maximum may be taken as negligible; nor is the formation of limestone necessarily a slow process. The successful experiments of Dr. Allan, cited by Darwin, prove that reef-building corals may grow at the astonishing rate of six feet in height per annum.

In respect of coal there is much to suggest that its growth was rapid. The carboniferous period well deserves its name, for never before, never since, have Carbonaceous deposits accumulated to such a remarkable thickness or over such wide areas of the earth's surface. The explanation is doubtless partly to be found in favorable climatal conditions, but also, I think, in the youthful energy of a new and overmastering type of vegetation, which then for the first time acquired the dominion of the land. If we turn to our modern peat-bogs, the only Carbonaceous growths available for comparison, we find from data given by Sir A. Geikie that a fairly average rate of increase is six feet in a century, which might perhaps correspond to one foot of coal in the same period.

The rate of deposition has been taken as uniform through the whole period of time recorded by stratified rocks; but lest it should be supposed that this involves a tacit admission of uniformity, I hasten to explain that in this matter we have no choice; we may feel convinced that the rate has varied from time to time, but in what direction, or to what extent, it is impossible to conjecture. That the sun was once much hotter is probable, but equally so that at an earlier period it was much colder; and even if in its youth all the activities of our planet were enhanced, this fact might not affect the maximum thickness of deposits. An increase in the radiation of the sun, while it would stimulate all the powers of subaerial denudation, would also produce stronger winds and marine currents; stronger currents would also result from the greater magnitude and frequency of the tides, and thus while larger quantities of sediment might be delivered into the sea, they would be distributed over wider areas, and the difference between the maximum and average thickness of deposits would consequently be diminished. Indications of such a wider distribution may perhaps be recognized in the Paleozoic systems. Thus we are compelled to treat our rate of deposition as uniform, notwithstanding the serious error this may involve.

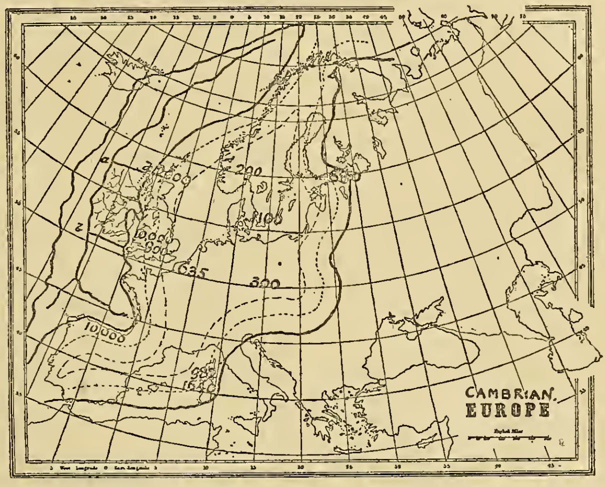


FIG. 2.—Chart of the distribution of land and sea, and of the thickness of deposits of the Cambrian system. The dotted lines indicate distances of 100 and 200 miles from the shore.

The reasonableness of our estimate will perhaps best appear from a few applications. Fig. 2 is a chart, based on a map by De Lapparent, representing the distribution of land and sea over the European area during the Cambrian period. The strata of this system attain their maximum thickness of 12,000 feet in Merionethshire, Wales; they rapidly thin out northwards, and are absent in Anglesey; scarcely less rapidly towards Shropshire, where they are 3,000 feet thick; still a little less rapidly towards the Malverns, where they are only 800 feet thick; and most slowly towards St. David's Head, where they are 7,400 feet thick. The Cambrian rocks of Wales were in all probability the deposits of a river system which drained some vanished land once situated to the west. How great was the extent of this land none can say; some geologists imagine it to have obliterated the whole or greater part of the North Atlantic Ocean. For my part, I am content with a somewhat large island. What area of this island, we may ask, would suffice to supply the Cambrian sediments of Wales and Shropshire? Admitting that the area of denudation was ten times as large as the area of deposition, its dimensions are indicated by the figure *a b c d* on the chart. This evidently leaves room enough on the island to furnish all the other deposits which are distributed along the western shores of the Cambrian sea, while those on the east are amply provided for by that portion of the European continent which then stood above water.

If one foot in a century be a quantity so small as to disappoint the imagination of its accustomed exercise, let us turn to the Cambrian succession of Scandinavia, where all the zones recognized in the British series are represented by a column of sediment 290 feet in thickness. If 1,600,000 years be a correct estimate of the duration of Cambrian time, then each foot of the Scandinavian strata must have occupied 5,513 years in its formation. Are these figures sufficiently inconceivable?

In the succeeding system, that of the Ordovician, the maximum thickness is 17,000 feet. Its deposits are distributed over a wider area than the Cambrian, but they also occupied longer time in their formation; hence the area from which they were derived need not necessarily have been larger than that of the preceding period.

Great changes in the geography of our area ushered in the Silurian system: its maximum thickness is found over the Lake district, and amounts to 15,000 feet; but in the little island of Gothland, where all the subdivisions of the system, from the Landovery to the Upper Ludlow, occur in complete sequence, the thickness is only 208 feet. In Gothland, therefore, according to our computation, the rate of accumulation was one foot in 7,211 years.

With this example we must conclude, merely adding that the same story is told by other systems and other countries, and that, so far as my investigations have extended, I can find no evidence which would suggest an extension of the estimate I have proposed. It is but an estimate, and those who have made acquaintance with 'estimates' in the practical affairs of life will know how far this kind of computation may guide us to or from the truth.

This address is already unduly long, and yet not long enough for the magnitude of the subject of which it treats. As we glance backwards over the past we see catastrophism yield to uniformitarianism, and this to evolution, but each as it disappears leaves behind some precious residue of truth. For the future of our science our ambition is that which inspired the closing words of your last President's address, that it may become more experimental and exact. Our present watchword is Evolution. May our next be Measurement and Experiment, Experiment and Measurement.

W. J. Sollas.

THE INTERNATIONAL CONGRESSES OF METEOROLOGY AND AERONAUTICS AT PARIS.

These Congresses were held nearly simultaneously on account of their allied interests. The Meteorological Congress, which began its sessions on September 10th, had the same character as the Congress held during the Paris Exposition of 1889, that is to say, it was open to all meteorologists, and although the countries participating in the Exposition were invited to send delegates, yet these had no power to pledge their respective countries to any action. More than thirty countries were represented this year at the Congress and about one hundred persons of various nationalities attended its sittings, which, consequently, were more truly international than was the case with any preceding congress. The absence of the Chief of the United States Weather Bureau was much regretted and the United States was represented solely by the officials in charge of the Weather Bureau exhibit at the Exposition and by the writer, who had also been the delegate of the United States in 1889. The place of meeting was again at the rooms of the Société d'Encouragement, outside the Exposition grounds.

M. Mascart, the director of the French Meteorological Office, was chosen president of the Congress, which he directed with his usual ability, being ably seconded by M. Angot as general secretary. Three vice-presidents represented England, Russia and Norway, respectively. At least half of the hundred papers presented were discussed by five standing committees whose sittings were open to any persons interested in the subjects. The most important work of the Congress was performed by these committees, foremost among them being the Aeronautical Commission, presided over by Professor Hergesell, that discussed the results obtained in the exploration of the atmosphere by the international use of balloons and kites, and the improvements that could be effected in instruments and methods. Professor Violle, as president of the Commission on Solar Radiation, summed up the state of the subject and heard several papers. Professor Rücker left the meeting of the British Association to preside over the Commission on Terrestrial Magnetism which had presented to it the work being done by magnetic observatories and surveys throughout the world. The Cloud Commission, the oldest of these committees, has always had at its head the indefatigable Professor Hildebrandsson, who was now able to summarize the results of the cloud measurements that through his efforts had been executed in various parts of the world during the so-called 'international cloud-year.' It was resolved to invite the meteorological observatories to undertake special observations of clouds each month on the days that the international ascents of balloons and kites were made in Europe. Eminently practical was the Commission for Weather Telegraphy, which proposed to accelerate the weather despatches in Europe by introducing the 'circuit system' of the United States, but found it necessary to refer the matter to the International Telegraphic Bureau at Berne. From the scope of these committees it will be seen that comparatively few subjects were left for discussion in the general sessions, which, consequently, had less interest than usual and served mainly to confirm the resolutions of the commissions.

Among the institutions visited, the most interesting was the observatory for dynamic meteorology at Trappes, near Versailles, where M. Teisserenc de Bort maintains an admirably equipped observatory, especially engaged at the present time in investigations of the upper atmosphere. This observatory, designed in general after that at Blue Hill, possesses, besides, means of obtaining temperature data at very high altitudes by the 'ballons-sondes' which are sent up twice a week and carry self-recording instruments to the height of ten miles or more. Owing to the many distractions of Paris, the only general entertainment was the banquet on the Eiffel Tower, and this was notable for the eloquent discourse of M. Leygues, Minister of Public

Instruction, who welcomed the meteorologists assembled from all parts of the globe as engaged in a science that benefits humanity and is independent of nationality. Coincident with the Congress, the International Meteorological Committee held a meeting and filled the vacancies existing in it, caused by the retirement of Dr. Scott, of England, and Professor Tacchini, of Italy, by electing to membership Dr. Shaw and Professor Palazzo, their successors as heads of the meteorological bureaus in their respective countries. Professor Hildebrandsson becomes secretary of the committee, a position long and faithfully filled by Dr. Scott.

The Aëronautical Congress convened on September 17th, the day that the Meteorological Congress adjourned. The general sessions were held at the Astro-physical Observatory at Meudon, but the sections met at the Institute of France in Paris. The committee of organization continued in office, namely M. Janssen as president and M. Triboulet as general secretary. Among the honorary vice-presidents was Professor Langley, who, with the writer, was a delegate of the United States. No other Americans attended the meeting, and the difficulty of getting to Meudon, no doubt, was one reason why so few persons came of the one hundred and fifty enrolled. M. Janssen's address was a masterly *résumé* of the progress of aëronautics since the Congress of 1889, and contained appreciative mention of the exploration of the atmosphere by balloons and kites. In speaking of the future, M. Janssen predicted that the nation which first learned to navigate the air would become supreme, for while the ocean, which has given preeminence to the people using it most, has its boundaries, the atmosphere has none. What then, asked the illustrious orator, will become of national frontiers when the aërial fleets can cross them with impunity? Two important conferences were given by the Renard brothers, the well-known officers in charge of the Central Establishment for Military Aëronautics at Chalais-Meudon. Major Paul Renard described the present state of aëronautics as exemplified at the Exposition. Colonel Charles Renard, who, with Major Krebs as collaborator, constructed at Chalais in 1884 the dirigible balloon named *La France*, the performance of which has never been equaled, gave a critical account of the various attempts to navigate the air by such balloon methods, terminating with the balloons recently constructed by M. Santos-Dumont in Paris and the huge one of Count von Zeppelin on the Lake of Constance. The other lectures were by M. Teisserenc de Bort on the meteorological results at Trappes from 'ballons-sondes' and kites and by the writer on the use of kites at Blue Hill to bring down such data from altitudes of three miles. In Paris special and technical papers were presented to four sections relating to different branches of aëronautics, and at the closing general session these communications were summarized and some resolutions were adopted. An international aëronautical committee was appointed, consisting, besides the officers of the Congress, of ten Frenchmen and ten foreigners, whose duty it is to advance aëronautical work throughout the world. On September 21st a delightful banquet at the Orangerie of the Château of Meudon, where the first balloons were constructed during the Empire, closed the Congress, and predictions were freely made that the conquest of the air was near at hand and that possibly members might come to the next reunion in aërial conveyances.

The noteworthy feature of this meeting, which could hardly be called international, was the demonstration of the practical status of aëronautics in France. Through the courtesy of the Minister of War, the establishment of Chalais was opened to the public for the first time, permitting the construction and manipulation of the war-balloons to be seen, and what was more interesting to the student, the apparatus employed by Colonel Renard in determining the resistance of the air to various bodies moving through it. At the Park of Vincennes, in connection with the aëronautical section of the Exposition and through the cooperation of the Aëro-Club, balloon races were organized, and each Sunday the novel spectacle was presented of a great number of balloons starting on their journey without delay or difficulty. On one afternoon seventeen balloons rose successively, each aëronaut endeavoring to land as near as possible to some point that he had fixed beforehand. The skill shown in utilizing the prevailing currents and in manipulating the guide-ropes may be inferrèd from the fact that one aëronaut, after a voyage of thirty miles, landed within half a mile of his goal. The same evening eight more balloons ascended and on the following Sundays there were competitions for height and distance. In the former contest a balloon, filled with 106,000 cubic feet of illuminating-gas and carrying a single aëronaut rose more than 27,000 feet, a height never before attained in France, unless perhaps by the ill-fated *Zenith*, when two of its passengers were asphyxiated. In the final long-distance race, about 1,400 miles were traversed in thirty-seven hours and three of the six balloons landed in Russia. All these voyages, accomplished without accident, tend to popularize ballooning as a sport and to facilitate its practical employment whenever the dirigible balloon shall be realized. As before mentioned, a very interesting attempt to solve this problem is being made at Saint Cloud, near Paris, by M. Santos-Dumont, who sits beneath a cigar-shaped balloon and controls a gasoline engine driving the propeller placed in front. In the trial witnessed of his balloon No. 4 an accident to the rudder made it necessary to hold the balloon captive but, nevertheless, it advanced into a light wind and was easily managed. This balloon will compete for the Deutsch prize of twenty thousand dollars for a voyage to the Eiffel Tower and back, a distance of seven miles, in half an hour. The aëronautical exhibit in the Champ de Mars was chiefly retrospective, but a novelty was the *Avion*, or flying machine of M. Ader, which resembles a gigantic bat and although it has never been tried in the open air yet the ingenious construction of the supporting surfaces and the extreme lightness of the steam-engine rendered it an object of attention. The kite competition at Vincennes, which the writer was called upon to judge, was several times postponed for lack of wind and had little interest, since the cellular kite of M. Lecornu was the only one possessing merit.

The Congresses of Meteorology and Aëronautics in 1900 are especially interesting as affording a general retrospect of the progress made by the twin sciences in the century just closing, and as giving a forecast of their possibilities in the next century, for meteorology and aëronautics are mutually dependent upon each other. The exploration of the air will give a better knowledge of the meteorology of the upper regions and perhaps will result in a more complete utilization of natural forces, such as solar energy and wind. The sea, at present the great medium of international communication, is only navigable on its surface while the aëronaut can use a vast depth of atmosphere and, while oceans separate continents, the atmosphere unites and dominates them. It is certain, therefore, as M. Janssen said, that man will not stop until he has conquered the last domain open to his activity.

A. LAWRENCE ROTCH.

SCIENTIFIC BOOKS.

Die Elemente der Entwickelungslehre des Menschen und der Wirbelthiere. Von Oscar Hertwig. Jena, Gustav Fischer. 1900. 8vo. Pp. vi + 406, mit 332 Abbildungen im Text.

This work is an abbreviated reissue of the author's well-known 'Lehrbuch'—the new work being about one-third the size of its parent. There is otherwise exceedingly little change, for there is no important modification of the general plan or of the style of treatment or in the point of view from which the author treats his subject. There has been no effort at all to recast the work so as to render it more suited to the requirements of embryological study in the laboratory. The text is taken from the 'Lehrbuch,' with here and there modifications of the phraseology, and with connecting new short parts to supply the place of some of the elided portions. The figures are nearly all from the 'Lehrbuch.'

Those who are familiar with the larger text-book will therefore have a very good conception of the character of the new volume and will find again the familiar merits and defects.

The author has been one of the foremost of embryological investigators, confining, however, his original researches to a few fields. On such topics as the history of the genital products he writes with full mastery of the subject, and his fine gift for the understanding of morphological problems, and his rare ability as an expositor, have combined to render all such parts of the volume of the very highest excellence. Unfortunately he seems to have been indifferent to the study of many other aspects of embryological study, and to have been satisfied with a somewhat vague aquaintance with many important parts of the science. This general defect shows very strongly in the absence of original illustrations, and in the fact that a large proportion of the minority of original figures are diagrams. Of these diagrams some are strangely incorrect, as, for instance, those of the development of the middle germ layers and those of veins. These diagrams indicate developmental processes, which are diametrically opposed to the observed facts. Equally unfortunate are his diagrams of the fœtal envelopes in birds and in mammals, since they are in part quite erroneous. As some of the figures are copies after inaccurate originals, there is need for still further revision: thus in Fig. 144, the amnion and chorion are wrongly represented, and the epithelium of the chorion is not only misdrawn but is labeled *decidua reflexa.* There are in the text also deficiencies which would certainly be corrected if the author's study of the embryonic conditions were made to a larger degree at first hand, for example, and notably in the case of the liver, the veins, the thymus, the pharynx and its appendages, the brain and certain other parts.

But though one may regret these and other deficiencies, some of which are very difficult to excuse, it remains true that the book deserves far more praise than fault-finding, and it ought to have a generous and hearty welcome, so that further editions may be called for soon, in which the author will have an opportunity to make the much-needed improvements. It is with regret that the reviewer finds himself obliged to qualify his recommendation of a work which he has found very helpful and stimulating.

C. S. Minot.

Studies of American Fungi: Mushrooms, Edible, Poisonous, etc. By George Francis Atkinson, Professor of Botany in Cornell University, and Botanist of the Cornell University Agricultural Experiment Station. Andrus & Church, Ithaca, N. Y., U. S. A., publishers. 8vo. Pp. i–vi, and 1–275, with 76 plates and over 150 text illustrations. Price, $3.00, postpaid.

In the publication of this book, which has just come from the Genesee Press, Rochester, N. Y., it seems desirable that the author should call attention to some of its features, the importance of which might at first be overlooked. In this connection it may not be out of place to first make some general statements regarding the book, a few of which are adapted from the introduction.

Since the issue of my 'Studies and Illustrations of Mushrooms,' as bulletins 138 and 168 of the Cornell University Agricultural Experiment Station, there have been so many inquiries for them, and for literature dealing with a larger number of species—it seemed desirable to publish, in book form, a selection from the number of illustrations of these plants which I have accumulated during the past six or seven years. The selection has been made of those species representing the more important genera, and for the purpose of illustrating, as far as possible, all the genera of agarics found in the United States. This has been accomplished except in a few cases of the more unimportant ones. Nearly all of these genera, then, are illustrated by photographs and descriptions of one or several species, and in the more important genera like *Amanita*, *Lepiota*, *Pleurotus*, *Mycena*, *Lactarius*, *Russula*, *Paxillus*, *Agaricus*, *Coprinus*, etc., a larger number of species are very fully illustrated, showing stages of development in many instances, and with a careful comparison of the different kinds.

Among the other orders of the higher fungi many genera and species of the *Polypores*, *Hedgehog Fungi*, *Coral Fungi*, *Trembling Fungi*, *Puff Balls*, *Stinkhorns*, *Morels*, etc., are illustrated and described. Among these such genera as *Boletus*, *Fistulina*, *Polyporus*, *Hydnum*, *Clavaria*, *Tremella*, *Morchella*, etc., come in for a large number of species with beautiful photographs and careful descriptions. In making the descriptions they have been drawn from studies of living specimens, in many cases showing important characters of development. An attempt has also been made to avoid, as far as possible, technical terms; or to use but few such terms, and the descriptions are intelligible to one who is not a technical student of the fungi. There is some progression in the use of the technical terms in the book, fewer of them being employed in the first part of the book; here they are explained, so that the reader becomes gradually familiar with them. The first few chapters are devoted to a description, in plain language, of the form and characters of mushrooms, as well as the course of development. In addition, there is a chapter, at the close, dealing with the more technical characters, and illustrating them.

There are chapters on the collection and preservation of the fleshy fungi, how to photograph them and keep records of the important characters, which often disappear in drying; on the selection of the plants for the table, etc. Mrs. Rorer contributes an excellent chapter on 'Recipes for cooking Mushrooms,' and Mr. J. F. Clark one on the chemistry and toxicology of mushrooms. There are also complete analytical keys to the genera of the agarics found in the United States, and keys to the orders of the higher fungi. The glossary deals only with the few technical characters employed in the book.

The photographs have been made with great care after considerable experience in determining the best means for reproducing individual, specific and generic characters, so important, and so difficult to preserve in these plants, and so impossible, in many cases, to accurately portray by former methods of illustration. Over 200 of the illustrations are half-tone engravings from these photographs. Seventy of these are used as full-page plates and over 150 of the half-tones are text illustrations. Fifteen additional species are illustrated in color. In the legend of the half-tones, text illustrations, as well as plates, the color of the cap, stem and gills is given.

One feature, which the author regards as a very important one, needs explanation, since it might seem unnecessary to some to introduce it in the book. There is at present so much confusion in the determination of the American mushrooms, and so many references to them are made in some publications, which are unsupported by any evidence which would serve as a guarantee that the species has been rightly determined, or that it occurs at all in the locality cited, I have followed the plan in late years of preserving all the material from which the photographs are made, even of the common species.

Furthermore, all material collected and preserved for the herbarium, or for photographic purposes, is entered in a record book, even different collections of the same species, so that this material if divided and distributed will carry the original number. The negatives and photographs carry a corresponding number. In nearly all the photographs in this book, then, it is possible to find the actual specimens from which the photograph has been made if ever any doubt should arise as to the correct determination of the illustration in question. For this reason the number of the specimens from which the photograph has been made is given in parentheses usually following the description of the species. These specimens and photographs, then, become of nearly, if not quite, equal value to type specimens.

The purpose of the book is to present the important characters which it is necessary to observe, in an intelligible way ; to present life-size photographic reproductions accompanied by plain and accurate descriptions, so that by careful observation of the plant, and by comparison with the illustrations and text, even a beginner will be able to add many species to the list of edible ones, where now, perhaps, the collections are confined to the 'pink unders.' The number of people in America who interest themselves in the collection of mushrooms for the table is small compared with those in some European countries. This number, however, is increasing, and if a little more attention were given to the observation of these plants and the discrimination of the more common kinds, many persons could add greatly to the variety of foods and relishes with comparatively no cost. The quest for these plants in the fields and woods would also afford a most delightful and needed recreation to many, and there is no subject in nature more fascinating to engage one's interest and powers of observation.

In addition to the purposes named above, the book has others. There are many important problems for the student in this group of plants. Many of our species and the names of the plants are still in great confusion, owing to the very careless way in which these plants have usually been preserved, and the meagerness of recorded observations on the characters of the fresh plants, or of the different stages of development. The study has also an important relation to agriculture and forestry, for there are numerous species which cause decay of valuable timber, or by causing 'heart rot' entail immense losses through the annual decretion occurring in standing timber. If the book contributes to the general interest in these plants as objects of nature worthy of observation ; if it succeeds in aiding those who are seeking for information of the edible kinds ; and stimulates some students to undertake the advancement of our knowledge of the group which may form a more scientific basis for their arrangement, it will serve the purposes the author had in mind in its preparation.

GEO. F. ATKINSON.

Engine Tests. By GEORGE S. BARRUS, S.B., New York, D. van Nostrand Co. 1900. 8vo. Illustrated. Pp. 338.

This work is of a kind always welcomed by the scientific practitioner in engineering ; it is a collection of experimental data gathered together by a well-known and skilled expert of rare experience and, what is still more rare, one who is accustomed to compel every scientific device and method to his service in his professional work. Mr. Barrus was one of the first in his profession to make use of the laboratory and exact scientific methods of determining the quality of steam supplied by the boiler and received at the engine, and to correct the previously always approximate figures for engine and boiler efficiency by reference to this datum. He had the exceeding good fortune to be engaged in some of the first and most important of the scientific studies of engine and boiler efficiency made at the Massachusetts Institute of Technology. He went out into an extensive and varied and fruitful practice as consulting engineer for New England steam users and carried with him that knowledge of scientific methods and that appreciation of their value which made him a pioneer in the introduction of precise measurements into the practical work of the engineer. His publications represent the outcome of twenty-five years of excellent scientific work.

In 1891 Mr. Barrus published a volume of selected reports upon steam-boiler efficiencies, and its reception was such as to induce him to publish this volume on steam-engine data. The two volumes probably contain a larger body of recent and exact data of this kind than any similar mass of existing technical literature.

The introductory portion includes a carefully written account of the methods employed in securing the data submitted, as of measuring the feed-water, determining leakage, calibration of the delicate instruments employed, conduct of the work of collecting data, method in detail of working up results from the logs and indicator diagrams, and methods of adjustment of system of test to character of engines and boilers in hand.

A second part presents the details of tests of simple, compound and triple expansion engines, summaries of the work, and a review in which are given his deductions as to magnitude and character of internal thermal wastes, effects of varying engine-speeds, steam-pressures, superheating, condensing, and the relative values of the types of engine described, effects of steam-jacketing and of reheating in multiple-cylinder engines and of variations of proportion. The pressure diagrams taken with the indicator from the steam-chest or the steam-pipe of the engine constitute a rare collection of useful data. Sample indicator-diagrams are given from all the engines and are admirably reproduced by the engraver. The book is printed upon heavy calendared paper and is a good piece of work.

The deductions and conclusions of the author are likely to be very helpful to the practitioner and there still is left for the reader the opportunity to study out many interesting, and some valuable, practical and scientific facts, laws and important conclusions.

R. H. THURSTON.

Experimental Chemistry. By LYMAN C. NEWELL, Ph.D. (Johns Hopkins), Instructor in Chemistry in the State Normal School, Lowell, Mass. Boston, D. C. Heath & Co. 1900. Price, $1.10.

The aim of this book as expressed in the preface is 'to provide a course in chemistry which shall be a judicious combination of the inductive and deductive methods.' The author has selected representative experiments and has left many of the properties, of the substances experimented with, to be determined in the laboratory by the student. A number of simple quantitative experiments and problems are given and several features are added which give considerable choice in the selection of topics for discussion. A number of subjects, suggested by the experiments, are given for discussion in the laboratory and a number of classroom exercises, in the shape of subjects concerning the historical and descriptive side of chemistry, suggest different phases of the science upon which emphasis can be laid. The book is clearly written and the explanations are sharp and to the point, and it will no doubt prove of value in normal schools and colleges. A teachers' supplement accompanies it.

J. E. G.

The Arithmetic of Chemistry. By JOHN WADDELL, B.Sc. (London), Ph.D. (Heidelberg), D.Sc. (Edin.), formerly assistant to the Professor of Chemistry in Edinburgh University. New York, The Macmillan Co. 1899. Pp. 136.

This book is intended to assist students in overcoming the difficulties they encounter in making chemical calculations. After describing the methods of calculating simple and complex weight relations, the author devotes chapters to the volume of gases, calculations involving weight and volume, calculations of analytical analysis and of formulæ. An appendix contains tables which may have to be consulted in making the calculations. In each chapter the principle is clearly explained by a number of examples, and a variety of problems taken from examination papers of different universities are given, which can be solved by the student. One who has worked through this book should have a good grasp of the principles involved.

J. E. G.

Die Chemie im täglichen Leben. Von PROFESSOR LASSAR-COHN. Vierte Verbesserte auflage. Hamburg, Leopold Voss. 1900. 4 Marks.

Few popular works on chemistry have earned recognition in as short a time and in such degree as this. Not a text-book, its popularity is solely due to its acceptance by the general reader. The first edition appeared in December, 1895, an English translation by M. M. Patterson Muir, with title, 'Chemistry in Daily Life,' being published shortly after by the J. P. Lippincott Co. Since then a Russian and an Italian translation have appeared, and also a second English edition, while translations into Servian, Portuguese, Bohemian, Swedish and Polish are announced.

The book is the record of popular lectures delivered at Königsberg. Teachers of chemistry will approve the skill and ease with which subjects seemingly difficult to present are made clear to the average reader. Among the topics treated are lighting, food, explosives, glass, soda, photography, paper, dyes, tanning, metallurgy, alloys. This work in the original or in the excellent English translation, should be in every school library and public library, for there is no other popular book giving the same information, while the information is given in an admirable way.

E. Renouf.

ANTHROPOLOGICAL PUBLICATIONS OF THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK, IN 1900.

The Thompson River Indians of British Columbia. By James Teit, Mem. of the Am. Mus. of Nat. History, Vol. II, and of Anthropology, Part IV, Vol. I. The Jesup North Pacific Expedition. New York, April, 1900. Pp. 163–390. Pls. XIV–XX. Figs. 118–315. Map. 4to.

Basketry Designs of the Salish Indians. By Livingston Farrand. Same Series, Part V. April, 1900. Pp. 391–400. Pls. XXI–XXIII. Figs. 316–330. 4to.

Archeology of the Thompson River Region, British Columbia. By Harlan I. Smith. Same Series, Part VI. May, 1900. Pp. 401–454. Pls. XXIV–XXVI. Figs. 331–380. 4to.

Symbolism of the Huichol Indians. By Carl Lumholtz. Same series, Part I, Vol. III. May, 1900. Pp. 1–228. Pls. I–IV. Figs. 291. Map. 4to.

Traditions of the Chilcotin Indians. By Livingston Farrand. Same Series, Part I, Vol. IV. Pp. 1–54.

The Jesup North Pacific Expedition, organized in 1897, has for its aim the history of man, past and present, dwelling on the coasts of the North Pacific Ocean. Beginning at the Amur River in Asia, the exploration will extend northwestward to Bering Sea and thence southeastward along the American coast as far as the Columbia River.

The generous patron, whose liberality made possible both the research and the enjoyment of it by the public through this series of monographs, is Mr. Morris K. Jesup, during the last twenty years President of the American Museum of Natural History, New York City. The execution of the tedious and difficult task is intrusted to the Anthropological Department, of which Professor F. W. Putnam is chief, the responsibility of the exploring and publishing falling on the shoulders of Professor Franz Boas. No pains or expense has been spared in the paper, the printing or the illustrations of the monographs. We do not like the size, 11 x 14 inches, although Berlin, Dresden and Philadelphia have set the bad example.

The Thompson River Indians and the Thompson River region come in for the lion's share of attention. This stream is a branch of the Fraser River, in middle British Columbia, its headwaters almost touching those of the Columbia and Mackenzie. The tribe here studied, better known as the 'Couteau' or 'Knife' Indians, belong to the Salishan family. There are 209 of them, and Dr. Boas finds their number decreasing. Mr. Teit, author of the monograph, is an old resident of the region, conversant with the language, and he has done his work under one of the foremost of ethnologists. His descriptions of dress, food, arts, trade, travel, transportation, warfare, social life, fine art, folk-lore and religion, supplemented by pictures drawn from specimens, and photographs made on the spot, form an ideal contribution to knowledge. From his minute examination it is shown that the Thompson River Indians and their ancestors were an upland people, influenced greatly by tribes farther eastward, little by those on the coast. They are not high in the scale of social organization or religion, and, like other Salishan tribes, have absorbed much and given out little.

Dr. Farrand's paper on basketry patterns is most timely. It not only rounds out Mr. Teit's studies, but it enters a new and inviting field. The basket fever is now raging, in most contagious form. The materials, patterns, stitches, colors and general designs are quite well understood; but no one dreamed until recently that there were mines of folk-lore in the patterns. The reader will find in Mr. Farrand's paper about forty of these from Thompson

River and Quinaielt baskets deciphered. We have lately heard that Fig. 9, Plate XXIII, for which Dr. Farrand was not able to obtain explanation, stands for the forms assumed in the clear fresh water lakes. This design reaches far to the southward. Dr. Hudson has gathered the meanings of about 80 symbols from the Pomos; Dr. Hough, many from the Mokis; and Mr. Roland B. Dixon understands many in middle California.

Complementary to Mr. Teit's studies is that of Mr. Harlan I. Smith, a trained archeologist, at Spence's Bridge, Kamloops, and in Nicola Valley, a former paper (III) being devoted to Lytton, at the junction of the Fraser and the Thompson. There is no evidence on the upper Fraser of great antiquity. One interesting discovery of Mr. Smith's was of rock-slide burial. The bodies of the dead were laid at the foot of a talus, at times covered with a framework as of a miniature tent. Rocks and débris were then slid down over all. In this exploration, the resources of the former population, including copper and nephrite, were brought to light, as well as their arts in stone, bone, shell, wood and textile. Not a shadow of pottery was encountered. The ancient people were hunters, fishers and 'diggers,' skin-dressers, stoneworkers and makers of basketry; they smoked and gambled. In fact, in all important respects they were the ancestors of the 'Couteaux.' They were not coast people, though they borrowed from the last named; but they had chosen affinities with tribes of Oregon and California, both physically and industrially.

Dr. Farrand's second paper (No. I of Vol. III) is devoted to the traditions of the Chilcotin Indians (Athapascan family), living on the Chilcotin River, a branch of the Fraser, 52° north. This tribe of Athapascans, wedged in between Wakashan and Salishan tribes, offers an extraordinary opportunity of testing the modern fad in ethnology, that of 'independent development.' We are not surprised to find a practiced field hand like the author saying "there is not a very rich, independent mythology, but surprising receptivity to foreign influences. * * * Comparatively few of the traditions exhibit unmixed Athapascan characteristics." Nearly every element of the culture-hero story is said to be found in one or more of the neighboring tribes, while in no one is there a complete correspondence in the whole myth. Mr. Farrand had a goodly mass of material for comparison in the voluminous writings of Father Morice, Abbe Petitot, Boas, Teit and Rand.

Mr. Lumholtz's generous monograph, of 228 pages, does not belong to the Jesup North Pacific Series, but treats of a little known tribe of Nahuatlan Indians, called Huichols, numbering 4,000 souls and living in the Sierras, on the Chapalangana River, a branch of the Rio Grande de Santiago, in the northwestern corner of the State of Jalisco, Mexico. These Indians, though conquered by the Spaniards in the 16th century, keep their ancient customs, beliefs, and ceremonies. Mr. Lumholtz devotes a few pages to the Huichols and their arts and then sticks bravely to his text, the patient detail of their symbolism. The four principal male gods are the god of fire, the chief deer god, the sun god, and the god of wind or air (Elder Brother, or Grandfather). The chief female deities are Grandmother Growth, Mother East-Water, Mother West Water, Mother South-Water, and Mother North-Water. Sacrifices are made to these and many others as prescribed.

The interesting cult of hi'kuli, the mescal button (*Anhalonium Lewinii*) is described and illustrated, and the names of cult animals identified. With great care the author sets forth and pictures the ceremonial dress and objects and symbols. Mr. Lumholtz's personal equation has a decided leaning against acculturation. This prejudice reaches its climax on page 206, where he figures a musical bow of African origin and says: "These facts settle beyond doubt the questions recently raised whether or not there is a musical bow indigenous to America. To deny its existence among the Coras and their northern neighbors would be equivalent to denying the originality of the Huichol drum." That is a little too strong. But the notched bones figured on the same page are infinitely more interesting, having a far more puzzling distribution. The concluding chapters, in which symbols and prayers are briefed and indexed, will enable the student to utilize the author's material economically.

For the series here described, the American Museum and Mr. Jesup, the Maecenas of American ethnology, deserve hearty praise. It is now in order for others of our great museums to wake up and let us hear from them.

O. T. MASON.

BOOKS RECEIVED.

Geometrical Optics. R. A. HERMAN. Cambridge University Press. New York, The Macmillan Co. Pp. x + 344. $3.

Photographic Optics. OTTO LUMMER. Translated and augmented by SYLVANUS P. THOMPSON. London and New York, The Macmillan Co. 1900. Pp. xi + 135. $1.90.

The Elements of Hydrostatics. S. L. LONEY. Cambridge University Press. New York, The Macmillan Co. 1900. Pp. x + 248 + xii. $1.00.

Botany. L. H. BAILEY. New York and London, The Macmillan Co. 1900. Pp. xiv + 355. $1.10.

A Text-book of Important Minerals and Rocks. S. E. TILLMAN. New York, John Wiley & Sons; London, Chapman & Hall (Ltd). 1900. Pp. 186. $2.00.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Bulletin of the American Geographical Society* for October 31, 1900, contains an excellent picture of the late president of the Society, the Hon. Charles P. Daly, which forms the frontispiece of this number. Judge Daly was the honored president of this, the oldest Geographical Society in America, and the portrait painted by Harper Pennington forms a fitting memorial of the thirty-five years of active service to the Society. The number contains a larger series than usual of what might be called new articles. First among these is an article upon the 'Ethnology of Madagascar,' by the Hon. W. H. Hunt, of Tamatave, dealing largely with the tribal names and the early immigrations, showing that there must have been a series of migrations from an Asiatic source. The second section of the paper discusses the early maps of the island, and then takes up the geography and cartography of Madagasgcar as developed between 1897 and 1899. This new work is due largely to the initiative of General Gallieni. This is followed by an article descriptive of the 'Heaths and Hollows of Holland,' by Dr. W. E. Griffiths, a bright and entertaining tale of this 'waterlogged' country and its people. 'Korea's Geographical Significance' is discussed by H. B. Hulbert, of Seoul, in a scholarly paper showing the relations brought about by this stepping stone from Asia to Japan, giving the results produced as a link between two widely separated branches of the Turanian stock; and then again when serving as a barrier between active Japan and ambitious Russia. Mr. Henry Gannett, of Washington, gives a careful *résumé* of the recent census of Porto Rico. This new addition to our domain has a population of 963,243, thus showing a very dense population of its 3,600 square miles. An outline sketch of the geography of British Honduras is given by Hon. W. L. Avery, of Belize. This is followed by an account of a trip through the silk and tea districts of Kiangnan and Chepiang, by E. S. Fischer. The portion of the *Bulletin* devoted to notes in this number is particularly full, and covers the departments of physiography, map notices, climatology, geographical education and the general geographical record. Cosmos Mindeleff gives a full account of the use and manufacture of geographical relief maps, and M. Henri Froideveaux gives a sketch of geography at the Paris Exposition. At the end of the number there is a picture of the new home of the Society, Manhattan Square on 81st street, giving a view of the front of the building and plans of the grounds and library floors. The enterprise of the Council in constructing this building as a repository for its fine library and a commodious place for the intercourse of the Fellows of the Society, is deserving of the highest praise.

The Plant World for October opens with 'Notes for the Beginner in the Study of Mosses,' by F. H. Knowlton, the first of a series on the lower plants. A. S. Hitchcock describes 'Collecting Sets of Plants for Exchange'; E. J. Hill has 'An Observation on the Water-Shield (*Brasenia peltata*), dealing with the dissemination of its seed; Charles Newton Gould describes the 'Radiate Structure of the Wild Gourd' (*Curcubita fœtidissima*), and Joseph Crawford has some 'Notes on Ophioglossum.' In the supplement devoted to 'The Families of Flowering Plants,' Charles Louis Pollard deals with the orders Verticellatæ, Piperales, Salicales and Juglandes and their allies.

THE *Journal of the Boston Society of Medical Sciences* for October begins with a discussion of 'The Antitoxin Unit in Diphtheria,' by Theobald Smith, detailing various experiments made, and concluding that at present we cannot do better than to utilize the standard provided by Ehrlich which is described in the paper. John Lovett Morse has an abstract of a paper on 'The Serum Reaction in Fœtal and Infantile Typhoid,' and Albert P. Matthews describes 'Artificially produced Mitotic Division in Unfertilized Arbacia Eggs,' caused by lack of oxygen, heat and the action of alcohol, chloroform and ether. Martin H. Fischer has a preliminary communication on 'The Toxic Effects of Formaldehyde and Formalin,' and William Sydney Thayer has some 'Observations on the Blood in Typhoid Fever,' being an analysis of the examinations of the blood in typhoid fever made in the Johns Hopkins Hospital during eleven years.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 327th regular meeting was held on Saturday evening, November 3d.

Under the head of 'Notes' F. A. Lucas described a specimen of the buffalo-fish, recently received by the U. S. National Museum, which had no mouth, the bones of the jaws having failed to develop. The fish must have fed by means of the gill openings and had attained a weight of more than a pound when caught. W. H. Dall called attention to the discovery, by Mr. T. Wayland Vaughan, of a fossil coral reef in Decatur Co., Georgia. This reef, which was of Oligocene age, resembled the fossil reefs in the Island of Antigua and was noteworthy from the large number of species represented, the reefs of the Tertiary beds usually being poor in the number of species of corals.

Under the title, 'Insects affecting Cotton,' L. O. Howard, following the 'symposium on cotton,' which occupied the last meeting of the Society, made some observations on the principal insect enemies of the plant. He presented accounts of *Aletia xylina*, *Heliothis armiger*, *Dysdercus suturellus*, and *Anthonomus grandis*, noting various outbreaks of these pests and describing their habits, transformations and the remedies employed.

Henry James spoke of 'Recent Progress in Forestry,' saying that the great obstacles to improvement in the management of forests in America were first, from the point of view of a forester, the new trees and conditions which have made the application of European methods in this country impossible, and, second, the almost total lack of examples of successful forest management.

During the last two years, however, this condition of things has greatly improved. The offer of the Division of Forestry, through the Department of Agriculture, to examine forest tracts and prepare 'working plans' for their management free of charge, has been taken advantage of on every side; and it has thus been made possible for the division to give object lessons in forest management in many parts of the country, and to gain knowledge and experience in a most practical way. In New York, for instance, a working plan is now being prepared for a part of the State Forest Preserve in the Adirondacks. On the Pacific coast the day of conservative lumbering is being brought nearer by investigations of the habits of growth and reproduction of some important lumber trees. These are making it clear among other things that the Red Fir and the Redwood reproduce more easily and will grow to a merchantable size much sooner than has hitherto been supposed. Similar observations are being made in other parts of the country, and interest in forestry is everywhere spreading rapidly. This is partly because people are realizing the importance of ample forest resources and a steady supply of water, partly because foresters can more often get down to terms which appeal to practical landowners. It means that soon many States will be following the example of Indiana, Pennsylvania and one or two others in taking hold in earnest of such important problems as those relating to protection from fire and reform in forest taxation. Forestry is appearing daily as something practical and desirable to more and more owners of forest land and voters generally who shape legislation.

M. W. Lyon presented some 'Notes on the Zoology of Venezuela,' stating that he spent the months of July and August in that country in company with Lieut. Wirt Robinson, collecting zoological material, especially the mammals. On the way down one day was spent at the interesting island of Curaçao, a few miles from the South American mainland. The mammal fauna of this dry and rather barren island consisted of several species of bats and a rabbit. Of the former eight are known to be peculiar, but related to the mainland forms, although one genus, *Leptonycteris*, has never been taken nearer than Central America. We are indebted to Mr. Guthrie, in the United States Weather Bureau Service, for our knowledge of Curaçaoan bats.

On the continent, collecting was confined to the vicinity of La Guaira, at the base of the extensive range of mountains that border the northern coast of South America. The first few hundred feet of hills about La Guaira are remarkably dry and covered with scrubby trees and bushes, agaves and post-cactuses, but at higher elevations where the moisture is greater is an abundant growth of tropical trees, shrubs and vines. The fauna of the dry region is quite different from that higher up, and consists principally of certain species of birds and lizards. Mammals, as well as more or less characteristic birds and reptiles, are apparently confined to the better wooded regions, or in the narrow valleys that the mountain brooks make on their way to the sea. There are no rivers in the neighborhood. Diligent trapping does not result in the numerous small mammals, as in temperate regions or certain places in the tropics. Bats are abundant in species and individuals, and may be found roosting in dense trees, in houses, or in the few small so-called caves in the region. Among the more interesting ones are disc-bats, of the genus *Thyroptera*, with a sucking disc near each wrist and ankle joint, by means of which it can adhere to and move over smooth surfaces as glass, in the manner of a fly, and the vampire, a moderately sized bat with a special dentition and alimentary canal for drawing blood from animals and digesting it. The native or spiny rat, *Loncheres*, while belonging to an entirely different section of the rodents, shows a striking external resemblance to the house rats found about the towns and brought in with the advent of the Europeans. Several other rodents occur and four species of opossums are found, including one of shrew-like form and habits, of the genus *Peramys*.

F. A. Lucas spoke of 'The Deposit of Mastodon Bones at Kimmswick, Missouri,' saying that this extraordinary aggregation of bones and tusks represented hundreds of individuals of all ages and sizes. But a small portion of the deposit had as yet been worked, but from this had been obtained teeth and bones representing between two hundred and three hundred animals. The full paper will appear in SCIENCE.

F. A. LUCAS.

DISCUSSION AND CORRESPONDENCE.

THE RELATION OF THE NORTH AMERICAN FLORA TO THAT OF SOUTH AMERICA.

TO THE EDITOR OF SCIENCE: In the interesting article by Professor Bray on the relations of the North American Flora to that of South America, in your issue of November 9th (pp. 10–11), there are some geological assumptions which are so at variance with the information now attainable that it seems well to call attention to them. It is true that most of them are of ancient date and found more or less accepted in the literature, and that their erroneous character does not materially affect Professor Bray's botanical conclusions; moreover, the present state of our knowledge has been set forth in the annotations to a table of our Tertiary horizons which appeared in the 18th Annual Report, U. S. Geological Survey, Part II, pp. 323–348, 1898. Nevertheless, they are so confidently stated by Professor Bray that it is quite likely that they may be accepted by botanical students and others not especially conversant with geology, and prove less innocuous than in the present case.

In the first place, Professor Bray has been misled by the long continued practice of authors in referring the basal Middle Oligocene of Central America and the West Indies to the Miocene. It was during this period that Central America formed a series of islands and the lagoon islets of south Florida first appeared above the sea. During the Miocene, however, there is no evidence that any part of Central America which is now above it was below the sea. No true marine Miocene beds have been recognized in any part of the Caribbean, Antillean or Middle American region. Florida alone shows Miocene, not only about the southern borders of the group of islets which formed the nucleus of the present peninsula, but also across the neck of the peninsula; which in Miocene times was a wide, shallow strait between the islands and the mainland of Georgia and has been named the Suwanee Strait.

Secondly, this Oligocene (formerly called Miocene) time was warm, but the true Miocene was a relatively cold period and is marked by a climatic change so sharp that the marine Oligocene fauna was almost wholly driven out of the Gulf and Floridian region, which was invaded by a cool-water fauna from the north, corresponding to the present fauna of New Jersey. The Arctic and Alaskan leaf beds, called Miocene by Heer, are now generally referred to some part of the Eocene column, and in Alaska are overlaid by the cooler marine fauna of the true Miocene. In the Pliocene, on the other hand, at least in Florida and the coast northeast of it as far as Chesapeake Bay and probably to Martha's Vineyard, there was a change to a warmer marine condition, which carried several semi-tropical forms of mollusks as far north as Massachusetts, and was accompanied by a slight subsidence in the Gulf region and on the Central American coast. In Tehuantepec the coastal plain was submerged to a depth of at least 600 feet, though whether the connection between the two oceans was renewed is not yet known. The ice age was, in the Gulf region, ushered in by a slight elevation of the land, and a return to slightly cooler conditions of the sea, but not to as great a degree as during the Miocene, the northern current, if any, being probably diverted off shore or cut off entirely.

Lastly, there is no reason, paleontologically speaking, for believing that the Antilles or the Florida peninsula has ever been connected with South America since the Mesozoic, if at all. On the contrary, there are strong reasons for believing that the insular condition has been maintained in nearly all the islands (excluding Trinidad and those adjacent to it) from an early period in the Eocene to the present day. It is probable that the distribution of the flora can be fully accounted for without resorting to the hypothesis of an unbroken land connection.

WM. H. DALL.
SMITHSONIAN INSTITUTION, November 12, 1900.

PALEONTOLOGICAL NOTES.

THESPESIUS VERSUS CLAOSAURUS.

IN 1856 Dr. Leidy described in the Proceedings of the Academy of Natural Sciences of Philadelphia two vertebræ and a proximal phalanx, for which he proposed the name of *Thespesius occidentalis*, stating that they probably came from some Dinosaur, although they might prove to be mammalian. Comparison of these bones with the similar parts of *Claosaurus annectens* of Marsh shows them to be identical and that consequently this Dinosaur must be known by Leidy's name.

A NEW LOCALITY FOR THESPESIUS.

THE U. S. National Museum has recently received from Mr. Harvey C. Medford, of Tupelo, Miss., the greater portion of the right femur of a large Dinosaur obtained near that place. This femur agrees exactly with the corresponding femur of a large and very complete specimen of *Thespesius occidentalis* collected by Mr. J. B. Hatcher in Wyoming, and certainly belongs to the same genus if not the identical species. This is the most southern locality for *Thespesius*, if not the first record of Dinosaur remains in the State of Mississippi.

THE DERMAL COVERING OF THESPESIUS.

THE impressions of the dermal covering of *Thespesius* (*Claosaurus*), noted by Mr. Hatcher in SCIENCE for November 9th, are of great interest, although they are not the first that have been discovered. Some years ago the U. S. National Museum obtained from Mr. Robert Butler a fine skull of *Thespesius*, together with other bones, and several pieces of sandstone bearing the impressions of small horny scutes, similar to those described by Mr. Hatcher.

THE DENTITION OF BASILOSAURUS CETOIDES.

IN the *American Naturalist* for August, 1894, attention was drawn to the fact that at least the lower molariform series of Zeuglodon contains six teeth, or one more than it is usually credited with. The specimen in the U. S. National Museum shows also that the first upper premolar is not a two-rooted tooth, but a single-rooted canimiform tooth having a very small accessory cusp on the posterior face. The first lower premolar is a large tooth with two roots. A jaw of *Dorudon* collected by Mr. Charles Schuchert seems to show that the Zeuglodonts were diphyodont, for it contains several teeth much smaller than those found in other specimens and these teeth had apparently not been fully extruded.

THE HYOID OF BASILOSAURUS.

Accompanying the skull obtained by Mr. Schuchert is a series of bones considered as constituting the hyoid. The complete hyoid is much like that of a toothed whale but with very much longer arches. The basihyal is flat beneath, slightly hollowed above, the ceratohyals are immensely long, 35 cm., and quite slender; the thyrohyals are stout at the point of articulation with the basihyal, taper slightly and are 25 cm. in length.

THE CRANIAL CAVITY OF BASILOSAURUS.

A cast made in the cranial cavity of an imperfect specimen of *Basilosaurus* shows the brain to have been comparatively smooth and of a most extraordinary shape, being very much wider than long, owing to its excessive prolongation in the auditory region. The separation between cerebrum and cerebellum was rather slight, the tentorium being a mere low ridge.

F. A. Lucas.

FORESTRY IN THE PHILIPPINES.

Strangely enough, there comes from our far distant possessions in the Pacific Ocean—which we are apt to think backward in all directions of economic development—a call for technically educated assistants in a branch of economics, which in our own country is only just beginning to be appreciated.

The Forestry Bureau at Manila, which is in charge of Capt. Ahern, U. S. A.—a most energetic officer who took great interest in advocating rational forestry methods for our public domain—is an inheritance from the Spanish government. It was established as long as 35 years ago, and employed 66 foresters, as many rangers and 40 other subordinates supervising the exploitation of the government forest property, which, according to estimate, comprises between 20,000,000 and 40,000,000 acres.

Capt. Ahern writes that he found 'the regulations in force in August, 1898, excellent, practicable and in line with the most advanced forestry legislation of Europe,' so that they could in the main be re-enacted, but, to be sure, the laws and regulations were not fully enforced and scientific forestry not practiced, and "it did not take long to develop the fact that the foresters knew very little of practical forestry, beginning their work after the trees had left the forest, not before, *i. e.*, devoting all their attention to collecting revenues."

At present even a revenue of about $8,000 per month is derived from licensees, who are mainly engaged in collecting guttapercha, rubber, gum, varnish, dye woods (some 17 kinds) and firewood, besides some of the very valuable hard woods.

Over 400 species of trees are known and a more careful survey will bring the number nearer 500. Of these at least 50 are valuable, the Yang-ylang tree being considered among the most important. This furnishes an oil which forms the base of many renowned perfumes. On the island of Romblon, a mass of cocoa palms, the result of planting under a former governor, covers the slopes from sea to mountain top, furnishing a yearly revenue of from one to two dollars per tree.

There are altogether, according to Blanco's magnificent work on the flora of the Philippines, 28 genera of palms with 87 species, the most important of which is *Coryphæa umbellaria.*

There are 22 species of Cupuliferæ, with two oaks (*Quercus costata* and *conocarpa*), and five genera of conifers with nine species; one only true pine, *Pinus insularis*, occurring in dense forests in the island of Luzon, above 4,000 feet altitude.

The families of Rubiaceæ, Rutaceæ, Ebenaceæ and Leguminosæ furnish quite a large number of arborescent species. Coffee trees grow wild on the slopes, replacing the original growth, when invaded by the wood chopper.

A very large number of the tree species have officinal value.

Means of communication are hardly yet developed, hence only the outer fringe of the forest has been cut away and lumbering is comparatively expensive, especially as no one gregarious species may be exploited, but, as is usual in tropic forests, a profusion of species occupies the ground; hence systematic exploitation which uses all that is valuable at one and the same time can alone pay for development of means of transportation. Capt. Ahern calls upon the N. Y. S. College of Forestry for six technically educated foresters to assist him in organizing his bureau on better lines than under Spanish rule and also proposes to send some Filipino college graduates to take forestry courses at Cornell. B. E. F.

PROFESSOR ROSS AND LELAND STANFORD, JR. UNIVERSITY.

The enforced resignation of Professor E. A. Ross from the chair of sociology at Leland Stanford, Jr. University is unfortunate, whatever the explanation may be. It is well known that Mrs. Stanford occupies a peculiarly responsible position in her relations to the university. She has, we believe, exercised her authority in the construction of buildings, etc., but never, heretofore, has interfered with the work of the professors. Professor Ross has made public a statement from which we quote the following paragraphs:

"At Stanford University the professors are appointed from year to year, and receive their reappointment early in May. I did not get mine then, but thought nothing of it until, on May 18th, Dr. Jordan told me that, quite unexpectedly to him, Mrs. Stanford had shown herself greatly displeased with me, and had refused to reappoint me. He had heard from her just after my address on coolie immigration. He had no criticism for me, and was profoundly distressed at the idea of dismissing a scientist for utterances within the scientist's own field. He made earnest representations to Mrs. Stanford, and on June 2d I received my belated reappointment for 1900–01. The outlook was such, however, that on June 5th I offered the following resignation:

"Dear Dr. Jordan—I was sorry to learn from you a fortnight ago that Mrs. Stanford does not approve of me as an economist and does not want me to remain here. It was a pleasure, however, to learn at the same time of the unqualified terms in which you had expressed to her your high opinion of my work and your complete confidence in me as a teacher, a scientist and a man.

"While I appreciate the steadfast support you have given me, I am unwilling to become a cause of worry to Mrs. Stanford or of embarrassment to you. I therefore beg leave to offer my resignation as professor of sociology, the same to take effect at the close of the academic year 1900–01.'

"When I handed in the above Dr. Jordan read me a letter which he had just received from Mrs. Stanford, and which had, of course, been written without knowledge of my resignation. In this letter she insisted that my connection with the university end, and directed that I be given my time from January 1st to the end of the academic year.

"My resignation was not acted upon at once, and efforts were made by President Jordan and the president of the board of trustees to induce Mrs. Stanford to alter her decision. These proved unavailing and on Monday, November 12th, Dr. Jordan accepted my resignation in the following terms:

"I have waited till now in the hope that circumstances might arise which would lead you to a reconsideration.

"As this has not been the case, I, therefore, with great reluctance, accept your resignation, to take effect at your own convenience.

"In doing so I wish to express once more the high esteem in which your work as a student and a teacher as well as your character as a man, is held by all your colleagues.'"

President Jordan is reported to have said: "In regard to the resignation of Dr. Ross, it is right that I should make a further statement. There is not the slightest evidence that he is a 'martyr to freedom of speech.' Nor is there any reason to believe that his withdrawal has been due to any pressure of capital or any sinister influence. I know that Mrs. Stanford's decision was reached only after long and earnest consideration, and that its motive was the welfare of the university, and that alone."

THE TELEPHONOGRAPH.*

The telephonograph is a combination of the phonograph with the telephone, and is intended to take and record telephone messages by automatic means, and, to a limited extent, give an answer in the same way. It is the invention of Mr. J. E. O. Kumberg, and an example of the instrument is to be seen at the office of Messrs. H. F. Joel and Co., 31 Wilson street, Finsbury. The combination is simple in general principle, but some ingenious mechanism has been introduced to make the working effective. The message is spoken by the person sending it into the telephone in the usual way, and the vibrations set up by the voice are caused to act upon a recording stylus by the impact of the sound-waves. In this way the wax cylinder in the office of the person spoken to is indented and a phonogram is produced. This, of course, can be read off at leisure in the usual way. The vibrations are transmitted either directly or indirectly, in the latter case an electrical current effecting the object. A highly-sensitive transmitter of any well-known form is used. If it is desired, the instrument may be so arranged that two wax cylinders, or phonograms, may be inscribed, the one being in the office of the sender, to be retained as a record, and the other, an exact duplicate of the first, being produced in the office of the receiver. To effect this end, the transmitter instrument has two channels or tubes for the sound-waves produced by speaking into the mouthpiece. One of these channels leads to the speaking or recording diaphragm of the instrument at the transmitting station, which engraves them upon the phonogram blank. At the same time identical sound waves are electrically conveyed to the receiving instrument at the distant station of the person spoken to, and are there imprinted on another phonogram blank. It is possible to throw the phonograph action out of play and use the telephone in the ordinary way.

Neither the telephone nor the phonograph is perfect in its action, and unpracticed persons are apt at times to experience some difficulty in translating the sounds either one or the other produces into articulate speech; and when the deficiencies of the two are combined difficulty is still more likely to arise, although proficiency is retained to a remarkable degree by practice. In order to overcome this defect a special design of recording diaphragm cell has been devised by the inventor. It consists of a double cell micro-diaphragm having two compartments, one of which is fitted with a multiple, or other suitable microphone diaphragm disc, and the other with a sensitive disc of glass. This receives the undulations produced by the sound-waves and communicates them to the recording stylus. Below the glass diaphragm is a guard, which serves to confine the sound, and also as a shield against the scraping noise which the stylus makes by cutting into the wax cylinder. One of the most important features of the invention is a floating weight controlled by a spring which is attached by means of a pivoted lever and a fine wire to the two discs, already mentioned, of the double cell micro-diaphragm. The pivoted lever carries the recording and reproducing tools by which the sound vibrations are respectively engraved upon or reproduced from the wax cylinder. The action of the weight is to give additional power, or perhaps, rather, additional certainty and steadiness to the reproducing tools. Such weights have before been used to supply what may be described as a fly-wheel effect, thus enabling the cutting tool to overcome any irregularities in the composition of the wax. The weight, however, is apt to rebound through its own momentum, and thus defeat the end for which it is provided. To overcome this defect a spiral spring is fitted in the machine under notice, with the result that the jumping or vibratory motion is damped. It is claimed that by this device a deeper cut is made in the wax cylinder than has been before obtained, and the reproduction of the sound waves is thereby made more perfect.

We lately had an opportunity of testing this invention to the extent of transmitting a message from one room to another adjoining, although the length of wire represented a considerable distance. As reproduced by means of the phonogram, on which the message was recorded, the words were distinctly audible, the

* From the London *Times*.

result being equal to that of an ordinary phonograph. Mr. Higgins, chief engineer to the Exchange Telegraph Company, has tested the apparatus over a line five miles in length. He reports that under favorable circumstances 'articulation is good, the impressions on the cylinder being as deep as the impressions made when speaking into an ordinary phonograph.' Large battery power was needed and a reinforcing current is required at the receiving and registering line.

In regard to the practical utility of the apparatus those who had experience with the telephone and the phonograph will be able to judge from the description here given. It would be most applicable in small offices where a limited staff is employed. Thus if the office is left without an attendant and a call is made the phonograph can be so set as to reply, "Mr. —— is out. The instrument is fitted with a telephonograph which will automatically take down any message you may send and Mr. —— will read it on his return." The arrangement of the mechanism is such that any number of messages up to an aggregate of 15,000 words may be taken in this way.

SCIENTIFIC NOTES AND NEWS.

Sir William Huggins, the eminent astronomer, will succeed Lord Lister as the president of the Royal Society. The other officers of the Society will remain as at present with the exception of certain members of the council. They will be as follows: Treasurer, Mr. Alfred Bray Kempe; secretaries, Sir Michael Foster, D.C.L., LL.D., Professor Arthur William Rücker, D.Sc.; foreign secretary, Dr. Thomas Edward Thorpe, C.B.; other members of the council, Professor Henry Edward Armstrong, V.P.C.S., Mr. Charles Vernon Boys, Mr. Horace T. Brown, F.C.S., Mr. William Henry Mahoney Christie, C.B., Professor Edwin Bailey Elliott, Dr. Hans Friedrich Gadow, Professor William Mitchinson Hicks, Lord Lister, F.R.C.S., Professor William Carmichael McIntosh, F.L.S., Dr. Ludwig Mond, Professor Arnold William Reinold, Professor J. Emerson Reynolds, D.Sc., Dr. Robert Henry Scott, Professor Charles Scott Sherrington, M.D., Mr. J. J. H. Teall, Sir John Wolfe-Barry.

These officers will be elected at the anniversary meeting of the Society on November 30th, when medals will be presented as follows: The Copley Medal to M. Berthelot, For. Mem. R.S., for his services to chemical science; the Rumford Medal to M. Becquerel, for his discoveries in radiation proceeding from uranium; a Royal medal to Major MacMahon, for his contributions to mathematical science; a Royal medal to Professor Alfred Newton, for his contributions to ornithology; the Davy Medal to Professor Guglielmo Koerner, for his investigations on the aromatic compounds; and the Darwin Medal to Professor Ernst Haeckel, for his work in zoology.

Lord Avebury has given the first Huxley Memorial Lecture which the Anthropological Institute of London has established to commemorate Huxley's anthropological work.

F. H. Snow, Chancellor of the University of Kansas and professor of organic evolution and entomology, has been given a year's leave of absence by the Board of Regents, on account of ill health.

Dr. L. O. Howard, chief of the Division of Entomology, U. S. Department of Agriculture, has been elected an honorary member of the 'Allgemeinen Entomologischen Gesellschaft.' The other honorary members are: Fr. Brauer, Vienna; Charles Janet, Paris; Sir John Lubbock, London; A. S. Packard, Providence, R. I.; J. A. Portchinsky, St. Petersburg; M. Standfuss, Zürich; E. Wasman, Luxemburg; Aug. Weismann, Freiburg.

Dr. Ramon y Cajal, the eminent histologist, has been awarded a pension by the Spanish Government, and additional funds have also been provided for the enlargement and maintenance of his laboratory.

Yale University has conferred the honorary degree of M. A. on Professor H. S. Graves, director of the Yale Forest School.

Professor Bemis, director of the New York State School of Ceramics at Alfred University, has been awarded a silver medal at the Paris Exposition for a collection of the economic clays of the United States.

Professor G. Frederick Wright, of Oberlin College, and Mr. F. B. Wright arrived at St. Petersburg on the 14th instant. It will be remembered that they were in the midst of the troubles in northern China.

Dr. N. L. Britton, director-in-chief of the New York Botanical Gardens, has returned from Europe, where he has secured a number of important collections and made arrangements for exchanges.

Llewellyn Le Count, assistant in engineering at Columbia University, died on November 15th at the age of twenty-two years. He was graduated this year from the school of applied science of the university.

The *Auk* records the death of Mr. Charles C. Marble until recently editor of *Birds*, a magazine of popular ornithology.

Applied science is deeply indebted to Mr. Henry Villard for his interest and faith in engineering works, especially the application of electricity before their commercial importance was commonly understood. Mr. Villard was also interested in pure science. Thus the Baudelier Expedition from the American Museum of Natural History to Peru and Bolivia was equipped by him in 1892, and he maintained it until 1894. The results of this expedition to the region of highest pre-Columbian culture in South America form the nucleus of the archeological collection that is now open to the public in the west gallery of the American Museum of Natural History. Mr. Villard also furthered investigations among the native peoples of the Columbia River Valley.

Tufts College will open a small laboratory for marine biology at South Harpswell, Maine, next summer. The fauna there is very rich, and the locality is a delightful one in which to spend the summer. There will be opportunities for a few investigators. All inquiries should be addressed to Professor J. S. Kingsley, Tufts College, Mass.

The meeting of Naturalists of the Central and Western States at Chicago, last year, was so successful that a second meeting will be held at the Hull Biological Laboratories, University of Chicago, on Thursday and Friday, December 27 and 28, 1900, when it is expected that a permanent organization will be effected. The provisional program is as follows: *Thursday*, 10 A. M.—General meeting in Room 24, Zoological Building (furnished with a projecting lantern), for organization and reading of the more general papers. 1 to 2 P. M.—Luncheon at the Quadrangle Club. 3 P. M.—Discussion: State Natural History Surveys; methods, results, cooperation. 6:30 P. M.—Dinner at the Quadrangle Club. *Friday*, 9 A. M.—General meetings for reading of papers. At this time at least two sections, one in Zoology and one in Botany, will be formed, at which the more special papers will be read. The committee on the meeting is E. A. Birge, *Chairman;* C. R. Barnes, T. G. Lee, C. C. Nutting and C. B. Davenport, *Secretary.*

The New York section of the Society of Chemical Industry holds its next meeting on November 23d at the Chemists' Club, 636 W. 55th Street, instead of at the College of Pharmacy as hitherto. The usual informal dinner before the meeting will be held at the Hotel Grenoble, 7th Avenue and 56th Street.

The American Forestry Association will hold a meeting in Washington, on the morning of Wednesday, December 12th. The meeting will be primarily a business meeting. The Board of Directors will make its annual report and officers will be elected for the ensuing year. Members who are in the neighborhood of Washington are urged to be present.

The National Irrigation Congress is meeting in Chicago this week. In addition to special papers on the scientific aspects of irrigation and forestry, addresses have been arranged by Secretary Wilson, of the Department of Agriculture, General Miles and other prominent men.

It is announced from St. Petersburg that Baron Toll's polar expedition, under the auspices of the Imperial Academy of Sciences, is wintering in the Kara Sea, on the northeastern coast of Siberia. It will send an expedition to the Taimyr Peninsula next spring to establish an observation station.

It will be remembered that Benjamin Franklin bequeathed to the city of Boston $5,000, the interest of which should accumulate for 100 years and then be used for public purposes. The period ended some six or seven years ago and there has been much difference of opiuion as to the disposition of the fund which now amouuts to $366,880. It appears, however, that a committee of the City Council and the managers of the fuud have agreed to recommend that the money be used for the erection of a building to be known as the Frauklin Institute, which shall be used for educational purposes, with special reference to artisans.

A number of American men of science were awarded gold and silver medals at the Paris Expositiou. A circular has been sent them, in lieu of the medals, statiug that these can be purchased—the gold medal for 600 fr. The value of the gold in the medal is not stated, but it probably allows a generous profit to the promoters of the Exposition. Electrotype blocks of the medals are also offered for sale at a cost that will allow somebody a profit of about 1,000 per cent.

Attempts have been made to sell a certain book by a person who styles himself 'President of the Natural Science Association of America,' and the name is now beiug used to promote the sale of mining stocks. There is probably no legal means of preventing the use of an honorable name for such purposes, but there should be some agency such as a committee of the National Academy of Sciences or of the American Association for the Advancement of Science that would prevent people from being deceived by the misuse of a name such as the 'Natural Science Association of America.'

Professor Smedley, supervisor of the Chicago Board of Educatiou's Department of Child Study has drawn, says the *Medical News*, the following conclusions from the examinations of the eyes of the school children : (1) Dull pupils have a greater number of eye defects than brighter pupils. (2) Defective eyesight causes dulness in the child. (3) The primary rooms in the public schools have the poorest light. (4) Boys have better sight than girls. (5) School life is responsible for many eye defects. (6) The first three years of school life increases eye defects one-third. (7) Of pupils whose sight is but one-tenth the keenness of normal, the number grows steadily larger from the beginning to the end of school life. (8) While in ordinary schools 32 per cent. had only two-thirds of ordinary keenness of sight, in one school 48 per cent. had that degree of eye defects. (9) Such defects undoubtedly were the cause of the presence of many of the pupils in that school. (10) Something must be done at once, at almost any cost, to save school children's eyes.

Professor Grassi has just published, says the *Lancet*, another note in the *Rendiconti della R. Accademia dei Lincei*, describing some observations made by him in September of last year and during the past summer at Grosseto with the object of controlling the results obtained last year in July and August by Professor Koch's expedition. The latter, it may be remembered, found very few *anopheles*, but a very great number of *culices* in this city, although malaria was very prevalent, and from this fact he considered it likely that *culex pipiens* is also an agent in the propagation of malaria. Professor Grassi, on the contrary, has found *anopheles* very abundant in the same houses where Koch had noted malaria the previous year, and he concluded from this that Professor Koch's party were inexpert at the work of lookiug for mosquitoes and that their search was not made in the proper places, which are the entrauces of houses and outhouses, and not in the bedrooms. He found that the favorite time for the *anopheles* to feed at Grosseto was the thirty or forty minutes immediately after sunset, and to a much less extent, the same time before sunrise. They take long flights in search of food and like to go away shortly after feeding, for which reason they may be said to chauge every twenty-four hours, at least during the warm weather, only very few (about 1 per cent.) being consequently found infected in the height of summer. As the weather becomes colder they remain longer and a large proportion (about 8 per cent.) are found infected. The infected insects are apt to be conveyed passively over long distances and so spread infectiou to fresh localities hitherto exempt. *Anopheles* are found in some places where no malaria exists as, *e. g.*, along the Lake of Como. Their larvæ live freely in salt water, and seaside places, though usually exempt, are not invariably so. Professor Grassi, in conclusion, confirms the observations of Christophers and Stephens on the occasional presence in the salivary glands of the *culex* of bodies which resemble, but which he does not believe to be, sporozoites. He calls them pseudo-sporozoites.

A paper on the metric system read by Mr. Rufus C. Williams, president of the New England Association of Chemistry Teachers, has been published in a pamphlet by the Decimal Association of London. It gives a very clear account of the advantages of the metric system. Mr. Williams reports that under the Government the system is used in the following cases:

1. In the Department of the Coast and Geodetic Survey, the meter was adopted as the standard in the beginning and has been so used ever since.

2. In the Agricultural Department, in all scientific work in chemistry, etc.; and in the Natural History work metric measurements are exclusively used.

3. The Post Office Department uses it for foreign mails to metric countries, but not for domestic. Postal cards are of metric dimensions, and certain coins have been made to metric weights and measures.

4. In the Department of Surgeon-General of the Army and also that of the Navy, all contracts for medical supplies embody the metric system, and all containers—boxes and bottles—are of metric dimensions.

5. Regulations for U. S. Marine Hospital Service, 1897, made its use compulsory.

6. In Cuba and Porto Rico the Government uses the system exclusively in all official and domestic work. These countries adopted it years ago.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. Andrew Carnegie proposes to erect and furnish buildings for a polytechnic school in Pittsburg, giving it an endowment fund of $1,000,000. The city of Pittsburg is to furnish the site.

The amendment to the constitution of the State of California, permitting Leland Stanford Jr. University to receive bequests from those not citizens of the State, and permitting the legislature to exempt part of the property of the University from taxation, was adopted at the recent election.

We recorded last week the partial destruction by fire of the N. Y. State Veterinary College of Cornell University. It appears that the damage to the building, which is estimated at $30,000, is covered by insurance. The departments of histology and bacteriology, however, lost equipments valued at $25,000 and collections that can scarcely be replaced. The loss of Professor Gage's collections, made in the course of twenty years, is especially serious. It is thought possible that the fire originated in the lamps of incubators in the department of bacteriology which were kept burning all night.

Professor George J. Brush, of Yale University, has given $1,000 to a special fund for the Sheffield Scientific School. The general funds of the school have been increased by a gift of $2,500 from an anonymous donor. The university has also received the following gifts and bequests: $5,000 from Mrs. Isaac H. Bradley, the income of which is to be devoted to a course of lectures on some subject connected with journalism, literature or public affairs; $700 by the will of the late James Campbell, of the medical faculty, to maintain the senior prize, provided for by him since 1888 and known as the Campbell gold medal; $1,000 from Mrs. H. F. English for the Alice Kimball English prize fund in the Art School and $1,000 from ex-President Dwight for the general funds of the Art School.

James Milliken, the Decatur (Ill.) banker and philanthropist, has added $400,000 to his gift to the proposed industrial school to be established in Decatur. He had previously given $316,000. Citizens gave $100,000, and the Cumberland Presbyterian churches of Illinois, Indiana and Iowa will give $100,000.

A compound engine to be placed in the boiler house erected by President Morton in connection with the Carnegie Laboratory of Engineering has been presented to the Stevens Institute of Technology by the Stevens family at Hoboken.

Dr. A. Kossel, professor of physiology at the University at Marburg, has been called to Heidelberg.

SCIENCE

Friday, November 23, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

The fourteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations was held at New Haven and Middletown, Connecticut, November 13th–15th. Most of the sessions were held in the assembly room of the Sheffield Scientific School of Yale University, where the delegates had the pleasure of meeting President Hadley, who delivered a short address. Professor W. H. Brewer, of the Sheffield Scientific School, and Dr. E. H. Jenkins, of the Connecticut Experiment Station, actively promoted the comfort of the delegates and the business of the convention. The Association went to Connecticut this year especially to celebrate the twenty-fifth anniversary of the founding of the Connecticut State Agricultural Experiment Station. The colleges and stations of all sections of the country were represented.

The report of the Executive Committee pointed out that Congress had recognized the importance of the land-grant colleges to the country in a notable way during the past year by providing that when the proceeds of the sale of public lands were insufficient to meet the annual appropriations for these institutions, the deficiency should be met by direct appropriations from the National Treasury.

President J. E. Stubbs, of the University of Nevada, presided at the general sessions and delivered the president's annual address. He took strong ground regarding the fundamental necessity for the direct and indirect teaching of sound moral principles in our public educational institutions of all grades. "It is character and not intelligence that determines the historical development of nations. It is character and not intelligence that distinguishes one individual from another and contributes to social well-being. The morality of the race, together with its strength and vigor, must be the principal object of education; all else is secondary."

A carefully prepared and eloquent address on the career of the late Senator Justin S. Morrill, of Vermont, was delivered by President G. W. Atherton, of the Pennsylvania State College. President Atherton's close association with Senator Morrill for many years and his intimate familiarity with the history of the movement for the establishment of colleges and agricultural experiment stations under national auspices enabled him to treat this subject in a very thorough and satisfactory manner, so that his address will have a permanent historical value.

Dr. Bernard Dyer, of London, England, as the representative of the Lawes Agricultural Trust, delivered the biennial course of lectures provided for in that Trust. In these he gave a *résumé* of the investigations at the Rothamsted Experiment Station during the past fifty years with different kinds of fertilizers on wheat, pointing out especially the effects of different systems of manuring on the amount and availability of the fertilizing constituents in the soils experimented with. It is expected that a detailed account of this work will be published later by the Department of Agriculture. Besides resolutions of thanks to Dr. Dyer, the Association adopted a memorial showing its high appreciation of the life and work of Sir John Bennet Lawes and his associates at the Rothamsted Station.

One day was spent at Middletown, where the Association was most cordially received and hospitably entertained by Wesleyan University. The delegates were also given a reception at the residence of Professor W. O. Atwater and had the opportunity of seeing the Atwater-Rosa respiration calorimeter in operation. At a meeting held in the University chapel, Dr. W. H. Jordan, Director of the New York State Experiment Station, gave a historical address on the American Agricultural Experiment Stations. Besides reviewing the rapid growth of this great enterprise from its beginning at Middletown twenty-five years ago and pointing out the great scientific and practical results which it has already achieved, Dr. Jordan strongly urged that the stations should use every effort to put their work more fully on a high scientific level and devote themselves very largely to original investigations.

He was followed by Professor W. O. Atwater, who gave a number of interesting details regarding the establishment of the Connecticut Station as the first State Station in this country and showed that the influence of this station had been very great in shaping the organization and work of other stations. He also pointed out that a relatively large number of men, now prominently identified with the experiment station enterprise in this country, had been trained at Yale University, Wesleyan University, and in connection with the work of the Connecticut Experiment Stations.

In the Section of Agriculture and Chemistry much attention was naturally given to discussions of investigations on tobacco, the Connecticut State Station being engaged in important work in this line. Dr. E. H. Jenkins, Director of the Connecticut State Station, read a carefully prepared paper on methods of experimenting with cigar-wrapper leaf tobacco, in which he showed that one important result of the experiments of the Connecticut Station has been the confirmation of the results obtained by the investigations under direction of Professor Milton Whitney, Chief of the Division of Soils of the Department of Agriculture, indicating that the character of the tobacco leaf is in a great degree dependent on the physical character of the soil in which the plant is grown. Professor M. A. Scovell, Director of the Kentucky Station, read a paper on the methods of growing and curing white Burley tobacco. In discussing these papers Professor Whitney brought out the interesting fact that, with scientific management of the crop, tobacco almost identical with that grown in Sumatra can be produced in the Connecticut Valley. Among other papers read in this section were those on tests in feeding dairy herds, by Professor C. S. Phelps, of the Connecticut Storrs Station; cooperative field experiments, by Director E. B. Voorhees, of the New Jersey Stations; on the raising of sugar beets as a new and profitable industry in this country, by Director I. P. Roberts, of the Cornell University Experiment Station; and on available energy in foods, by Professor W. O. Atwater.

The report of the section on Horticulture and Botany, presented by Professor S. A. Beach, of the New York State Station, showed that there had recently been a great growth of interest in the subject of plant breeding and that studies in this direction were being undertaken by both botanists and horticulturists. There is a marked tendency to devote relatively less time to systematic botany and give much more consideration than formerly to problems in plant physiology. The testing of varieties still occupies a large place in the work of the stations, but it is being supplemented by investigations conducted on a more scientific basis. Among the papers read in this section were the following:

'Plant Physiology in its Relation to Agriculture and Horticulture,' by F. Woods, Chief, Division of Vegetable Physiology and Pathology, Department of Agriculture; 'Grasses and Forage Plant Investigation in Experiment Stations and the Division of Agrostology,' by T. A. Williams, Division of Agrostology; 'Laboratory and Field Work for Students in Horticulture,' by E. S. Goff of Wisconsin; 'The Educational Status of Horticulture,' by F. W. Card of Rhode Island; 'What Our Experiment Stations have done in Originating Varieties of Plants by Crossing and Selection,' by B. D. Halsted of New Jersey; 'The Relation of the Section of Seed and Plant Introduction to Experiment tSations,' by Jared G. Smith, of the Department of Agriculture; 'Vegetation House arranged for Pot Experiments, by W. E. Britton of Connecticut.

The section on Entomology had a larger attendance than usual, and there was a full program, which brought out much interesting discussion. Among the papers read were the following:

'Observations on the Banding of Trees to Prevent Injury by the Fall Canker-worm,' by W. E. Britton of Connecticut; 'Suggestions towards Greater Uniformity in Nursery Inspection Laws and Rulings,' by E. P. Felt of New York; 'Nursery Inspection and Orchard Insecticide Treatment in Illinois,' by S. A. Forbes of Illinois; 'Entomology in the Southern States,' by H. Garman of Kentucky; 'Economic Entomology in Florida,' by H. A. Gossard of Florida; 'Experiences in Nursery and Orchard Inspection' and 'Some Recent Results with Hydrocyanic Acid in Large Buildings for the Destruction of Insect Pests,' by W. G. Johnson of Maryland; 'Danger to American Horticulture from the Introduction of Scale Insects,' by Geo. B. King of Massachusetts; 'Entomological Œcology,' by C. W. Woodworth of California; 'Recent Progress in Cotton Spraying, and New Designs for Cotton Sprayers,' and 'Some Cotton Insects and Methods for Suppressing them,' by Fred W. Mally of Texas; 'Observations on *Artace punctistriga*,' by H. A. Morgan of Louisiana; 'A Little Known Asparagus Pest' and 'A Power Sprayer for Asparagus,' by F. A. Sirrine of New York; 'Notes on Crude Petroleum and its Effects upon Plants and Insects,' by John B. Smith of New Jersey; 'Nursery Inspection in a State free from San José Scale,' by H. E. Summers of Iowa.

For this section, Professor H. Garman,

of Kentucky, reported in the general session that much progress is being made in the specialization of the work of the station entomologists, in instruction in entomology in colleges, and in the improvement of facilities for research and instruction in this branch. There is a marked increase in recent years in the amount of inspection work required of station entomologists, and problems relating to the organization and management of this work require very careful thought and attention. Uniformity of inspection laws was advocated. It was shown that inspection had already caused much greater carefulness among nurserymen, thus removing one of the main causes of the dissemination of injurious pests.

In the section on college work, President J. K. Patterson, of the Kentucky Agricultural and Mechanical College, made a strong appeal for more instruction in mechanic arts in the land-grant colleges.

The Committee on the Collective Experiment Station Exhibit at the Paris Exposition made its final report through its chairman, Dr. H. P. Armsby, of Pennsylvania. This showed that the exhibit had been very successful in attracting the attention of investigators and government officials of different countries. The Association was awarded a grand prize for the exhibit as a whole, and collaborators were recognized by the award of a grand prize to Dr. A. C. True, Director of the Office of Experiment Stations; gold medals to Professors E. W. Hilgard, W. O. Atwater, C. F. Vanderford, T. B. Osborne, W. H. Jordan, W. H. Evans, L. G. Carpenter and W. A. Henry; and silver medals to Professors Elwood Mead, Milton Whitney, C. F. Curtiss, P. H. Mell and Paul Schweitzer. Dr. S. M. Babcock was also given a grand prize in recognition of his successful scientific work on behalf of dairy husbandry.

The Committee on Graduate Study at Washington made the following recommendations which were adopted by the Association:

"In view of the improbability that the Smithsonian Institution will adopt the suggestions of this Association regarding the organization of a Bureau of Graduate Study, your committee recommends that the Association take no further action in this direction.

"The Committee also believes that for the present further advantage should be taken of the foundation already successfully laid by the Secretary of Agriculture, and it therefore recommends that the Association express its appreciation of the practical efforts which he has made on behalf of this movement, and ask him to consider the practicability of enlarging the present plan for graduate study in that department, and, if he deems it wise, to invite the cooperation of other departments of the Government, in order that wider opportunities may be open to the graduates of the institutions represented in this Association, as well as of other institutions, to engage in graduate study and research in connection with the work of the national Government."

One of the most important subjects on which the Association took action at this meeting was the report of the Committee on Cooperative Work between the Department of Agriculture and the Experiment Stations. This was carefully prepared by a thoroughly representative committee after consultation with the directors of the stations and was unanimously adopted by the Association. It commended the attitude of the present Secretary of Agriculture toward closer cooperation between the Department and the stations and pointed out the different ways in which the two institutions might aid each other. It also attempted to define the principles on which the joint work should be arranged and conducted and stated these in the following language:

"Your Committee would deem it desirable that both the Department and the stations should feel entirely free to propose joint experimentation or to decline a proposal for such work.

"It is very clear to the Committee that the autonomy of the stations should be preserved, and that the stations should in no sense become extensions of the divisions of the Department for purposes of experimental work. Not only is the autonomy of the stations necessary to the fulfillment of their function, but autonomy in scientific investigation is equally essential. Your Committee would therefore deem it desirable, where cooperative work would seem advisable, that the agreement take the shape of a formal contract between the station, as such, and the Department, as such, through the properly authorized channels of each. That is, that the high contracting parties be the station on the one hand and the Department on the other. Arrangements between individual officers in the two institutions are deemed inadvisable except under such contract.

"The cost of cooperation should be borne jointly by the station and by the Department, and the amounts to be expended should, as far as practicable, be definitely agreed upon and specified.

"While it is understood that an absolute guarantee of continuance cannot be given, yet there should be reasonable mutual assurance of a fixed policy, until the completion of the work undertaken.

"The results of the investigation should be available to both institutions, priority of publication being a matter of mutual agreement at the outset. In all cases publications should set forth that such work is the result of joint experimentation.

"Your Committee deems it very desirable that independent work be not undertaken in the several States by the Department without the knowledge of the station or consultation with the station, particularly along lines of investigation in which the State station is engaged.

"Whenever cooperation with practical men in the States is desired by the department in investigations, it is suggested that the State station be the agency through which such cooperation is conducted. For example, if the department wishes to distribute seeds or plants for cooperative work, the knowledge both of men and physical conditions on the part of the station should be made available.

"Your Committee makes the above suggestions realizing that they are in no wise complete and that the subject is one requiring further inquiry and consideration."

The Association also passed a resolution pledging its support to the Secretary of Agriculture in his efforts to adjust the compensation of persons employed in the higher technical and scientific positions in the Department of Agriculture in such manner as to secure and retain the services of thoroughly competent officers.

The following officers of the Association for the ensuing year were elected:

President, A. W. Harris, of the University of Maine; Vice-Presidents, J. K. Patterson, of the Agricultural and Mechanical College of Kentucky; W. H. Jordan, of the New York State Experiment Station; R. H. Jesse, of the University of Missouri; L. G. Carpenter, of the State Agricultural College of Colorado; and E. A. Bryan, of the Washington Agricultural College and School of Science; Secretary-Treasurer, E. B. Voorhees, of the New Jersey Experiment Stations; Bibliographer, A. C. True, of the Department of Agriculture; Executive Committee, H. H. Goodell, of the Massachusetts Agricultural College; Alexis Cope, of the University of Ohio; G. W. Atherton, of the Pennsylvania State College, and H. C. White, of the Georgia State College of Agriculture and Mechanic Arts.

Officers of Sections: Agriculture and

Chemistry, C. D. Woods, of the University of Maine, chairman ; College Work, J. H. Raymond, of the University of West Virginia, chairman ; B. O. Aylesworth, of Colorado Agricultural College, secretary ; Entomology, M. V. Slingerland, of Cornell University, chairman ; H. A. Morgan, of Louisiana University, secretary ; Mechanic Arts, H. W. Tyler, Massachusetts Institute of Technology, chairman ; F. P. Anderson, of Kentucky Agricultural and Mechanical College, secretary ; Horticulture and Botany, L. R. Jones, of the University of Vermont, chairman ; W. J. Green, of Ohio Experiment Station, secretary.

A. C. True.

RECENT WORK ON MOLLUSKS.

The land shell fauna of the Hawaiian Islands has been discussed by E. R. Sykes, with intercalations on anatomy by Lieutenant-Colonel Godwin-Austen.* Mr. Sykes has worked upon museum material, especially that collected by Perkins and the rich stores of the British Museum and the Boston Society of Natural History. He finds the number of species much exaggerated, as every one familiar with the group was well aware. The fauna is considered to be Polynesian and to show hardly any trace of Asiatic or American influence. Oahu is the center of distribution and the most populous in Achatinellidæ. The list given is a useful one, but the monographic study of the Achatinellas from an evolutionary standpoint remains to be written.

A. S. Jensen, of Copenhagen, initiates what promises to be a series of 'Studier over Nordiske Mollusker,' by an investigation of the forms and distribution of the boreal Myas.† The paper is illustrated by some excellent figures.

* *Fauna Hawaiiensis*, II., pp. 271–412, pl. 11, 12. 1900. 4to.

† *Vidensk. Meddel. nat. Foren i Kjobenhavn*, pp. 133–158. 1900.

F. C. Baker * discusses the gross anatomy of *Limnæa emarginata* Say, var. *Mighelsi*. There are six plates, two illustrating what the author believes to be the range of variation in the form of the shell, the others, which are rather diagrammatic, illustrating the anatomy. If carefully done, papers of this kind will have a permanent value.

M. Maurice Cossmann continues his phenomenal activity in the field of Tertiary mollusks, by a paper which is to be followed by others on the 'Mollusques Éocéniques de la Loire Inférieure.'† An interesting series of forms is figured, and it is curious to see how many of them recall parallel species from our own Claibornian horizon.

Mr. W. J. Fox in a recent number (306 p. 718) of this Journal refers to a shell named by Osbeck in his 'Reise nach ost Indien und China,' 1765, *Cunnus chinensis*. The objectionable generic name was doubtless derived from Linnæus, who used it in the manuscript of the Museum Ludovicæ Ulricæ for the shell now known as *Venus dione*. It was not published by Linnæus, who substituted *Venus* in the tenth edition of the Systema Naturæ and afterward in the Museum Catalogue referred to. A very interesting account of the gradual evolution of the early Linnæan generic names, and of the binomial system itself, will be found in a paper by the late Professor Sven Lovèn 'On the species of Echinoidea described by Linnæus,' in the *K. Svensk. vet. Akad. Handl.*, Bd. 13, IV., No. 5, 1887, pp. 3–60. Luckily Osbeck's application of the name referred to seems unidentifiable.

The great Baikal Lake of Eastern Siberia has long been regarded as having had connection with the sea at some previous epoch, and various opinions have been held

* *Bulletin Chicago Acad. Sci.*, II., No. 3, pp. 191–212. June, 1900.

† *Bull. Soc. Sci. Nat. Nantes*, I., pp. 307–336, pl. XXII.–XXVI. 1900.

as to which body of sea water it was originally connected with. Dr. W. Dybowski contends that the 'stammform' of one of the Baikal sponges (*Lubomirskia baicalensis*) is an inhabitant of Bering Sea. Hoernes has regarded the fauna of the lake as analogous to that of the Sarmatic beds of Southern Europe, but this analogy is hardly greater than it bears to various other late Tertiary lake-beds, including those of our Great Basin. In the September number of the *Nachrichtsblatt der deutschen Malakozoologischen Gesellschaft*, Dybowski announces the discovery of a Nudibranch (*Ancylodoris baicalensis*, Dyb.) and the presence of numerous Trochophora larvæ in April, in the lake. These being strictly marine animals, never before reported from fresh water, the evidence as to the lake's origin seems conclusive, and its character as a 'relicten-see' positively established.

Mr. Henry Hemphill has recently forwarded to the National Museum a photograph of a six-valved specimen of *Ischnochiton* obtained by him at San Diego, California. Seven-valved specimens (the normal number being eight) are known to be preserved in the British Museum and the Academy of Natural Sciences at Philadelphia; and now Mr. E. R. Sykes figures in the *Journal of Malacology* (VII., p. 164) a three-valved specimen of *Ischnochiton contractus* Reeve, from South Australia. The rarity of these abnormal individuals makes the discovery most interesting. In another note Mr. Sykes records the presence in the fauna of Natal of a species of the genus *Cryptoplax*, previously supposed to be confined to the Indo-Pacific and Australian provinces.

Dr. George W. Taylor, of Nanaimo, has added a new genus to the fauna of the Pacific coast in the shape of an undescribed species of *Phyllaplysia* (*P. Taylori*) which was found near Nanaimo on floating seaweed. The animal is of a clear lemon-yellow, about an inch in length and with a nearly smooth surface. The genus has heretofore been known only from the coasts of France and the Adriatic.

Pelseneer has been pursuing researches on the various mollusks believed to exhibit archaic features.* He devotes attention chiefly to the Chitonacea, the Docoglossa, Rhipidoglossa and Solenoconcha. His conclusions do not include any remarkable novelties, but afford in many cases additional confirmation of opinions long held or occasionally expressed by macologists. Thus he considers the metamerism of chitons to be a secondary, not primitive, condition; recognizes the features of the Docoglossa limpets which are analogous to those of the Amphineura, confirms the unlikeness of *Scissurella* to *Pleurotomaria* and the asymmetry of the epipodial processes in the Trochidæ. Some interesting new facts are recorded among the Pyramidellidæ; *Odostomia* was found to be hermaphrodite, but otherwise related to ordinary Pectinibranchs. The Scaphopods he considers to have distinct relations with the Rhipidoglossate gastropods, but one of the characters, the opening of the genital duct into the right nephridium, has already been shown to be fallacious by H. Fischer, the error being due to the torsion in the embryo. It is probable that this supposed relation will not be accepted by students of the group. In regard to the nephridia of both Docoglossate and Rhipidoglossate limpets, Professor Pelseneer is at variance with Erlanger; but in another contested hypothesis, the relation of the Placophora and Aplacophora, in which he differs from Thiele by regarding the groups as related, we believe Pelseneer to be right. At any rate, whether all details be confirmed by future research or not, the present paper contains much which will prove welcome to students of the Mollusks.

Mém. Acad. Roy. des Sci. de Belgique, LVII. 1899. Pp. 113.

Professor L. Cuenot (*Arch. de Biologie*, XVI., 1899) has published some interesting researches on the excretory organs and their functions in a variety of mollusks. In these he shows how different portions of the nephridia excrete different effete elements of the fluids of the body and how these functions are distributed. The memoir has been crowned by the Royal Belgian Academy.

An unusual condensation of embryonic stages has been observed in two nudibranchs, *Cenia cocksi* by Pelseneer, and in *Pelta coronata* by Vayssière. These embryos do not exhibit the usual embryonic velum and shell of other Opisthobranchs, but the body at an early stage becomes covered with vibratile cilia and rotates in the fluids of the egg (*Zool. Anz.*, XXIII., 1900).

In the *Proceedings of the Malacological Society* (IV., No. 3, October, 1900), Mr. M. F. Woodward gives some important information in regard to the anatomy of three members of the Volutacea, the significance of which is, however, somewhat obscured by the author's want of knowledge of the present state of the nomenclature. The paper gives a general account of the macroscopic anatomy of *Neptuneopsis Gilchristi* Sowerby, a newly described and peculiar form from South Africa, and of '*Voluta*' *ancilla* and '*Volutilithes*' *abyssicola*, Adams and Reeve. Of the anatomy of the latter nothing was known. The *Neptuneopsis* was described in a South African publication which has not reached this country, and is generally inaccessible, so it is to be regretted that Mr. Woodward did not recapitulate the shell characters for the benefit of students. The radula also had been abstracted from the specimen before it was received by him, so that the chief aids to systematic classification are wanting. However, it seems pretty certain, from the characters of the nervous system, that the animal is nearly related to the Volutidæ, and, since it has an operculum, probably to the true volutes which Mr. Woodward calls *Volutolyria*, a name which is an absolute synonym of *Voluta* (L.) Lamarck. Until more information is received it would be rash to come to more precise conclusions as to its systematic place.

The only data in relation to the anatomy of *Volutilithes* properly speaking (as far as one can judge from the shell, the type being *Voluta spinosa* Lam., a fossil species) were given by me in the *Proc. U. S. Nat. Mus.* (XII., No. 773, p. 315, 1889) from an examination of *V. Philippiana* Dall., from the South American coast. To the data there supplied it may be added that the dentition consists of a single longitudinal row of 50 tricuspid teeth, the cusps being long, thornlike and somewhat decurved. It has no operculum and is blind. This radula is most like that of *Cymba olla* L. and *Volutilithes* doubtless belongs to the *Scaphellidæ* as does *Cymbiola* (or *Scaphella*) *ancilla*. In 1890 I separated the group to which '*Volutilithes*' *abyssicola* belongs, as a subgenus *Volutocorbis*, as it obviously could not be classed with the original *Volutilithes*. This course is now fully justified by the anatomical details supplied by Mr. Woodward, the most remarkable of which is the radula, which has two rows of unicuspid laterals, one on each side of the rhachidian tricuspid tooth. This radula is unlike any of the Volutacea yet known, as *Volutomitra*, which Woodward compares with it, has, like the others, only a single row and Troschel in his text explains how the deceptive appearance of laterals in one of his figures arises from the crushing of the base under a cover glass. The single rhachidian of *Volutomitra* is well figured by Stimpson (*Bull. U. S. Nat. Mus.*, No. 37, pl. xxxiv., Fig. 7). The radula of *Volutocorbis* is intermediate between that of *Vasum* and that of *Oliva*. The group will now take rank as a distinct genus. If it remains in the Volutacea it must be placed in the Scaphellidæ. The chief distinctive characters of this family, beside the conditions of the larval shell and the absence of an operculum, appear, from Woodward's researches, to be the extreme condensation of the chief ganglia around the gullet, the development of a very large œsophageal cæcum (which led Poiret to suppose *Halia* had a double œsophagus), and two pairs of preneural salivary glands. If the family is divided into two subfamilies on the basis of the radula, Volutomitrinæ with a unicuspid median tooth, will include *Amoria*, *Volutomitra* and *Halia;* while Scaphellinæ with a tricuspid tooth will include the others. The typical *Voluta* and *Lyria* have wide rhachidian teeth with many cusps, an operculum, shelly protoconch, and other characters which separate them entirely from the Scaphellidæ. According to our present knowledge one of the most important results of Mr. Woodward's labors is to show that the old family of Volutidæ included many diverse types, and that a great deal remains to be done before we can proceed to generalize with safety on those of which the nepionic stages and anatomy are unknown.

WM. H. DALL.

RICHTER AND THE PERIODIC SYSTEM.*

A VERY remarkable work appeared at the close of the last century. This was 'Die Anfangs-gründe der Stöchyometrie,' by J. B. Richter, the first volume of which appeared in 1792, and the third and last volume in 1794. In this book we have the first definite statement of the law of proportionality, and some have thought that they have found in it also the Atomic Theory, though it was not claimed that this theory was definitely stated.

Richter's work attracted attention at the time because of his defense in it of the phlogistic theory and it was vigorously attacked by the supporters of the New Chemistry, who followed Lavoisier and the French chemists. The deeper purport of the book and the new ideas advanced do not seem to have been well understood or to have been largely commented upon. Fischer, who in 1802 translated into German Berthollet's 'Statique Chimique,' was apparently the first to draw general attention to the work of Richter and to its bearing upon the conclusions drawn by Berthollet. This latter chemist and Guyton de Morveau acknowledged that Richter had anticipated them in the inference to be drawn from the permanence of neutrality after the decomposition of certain neutral salts and the possibility of calculating beforehand the composition of the salts produced. The discovery of the law of proportionality was a most important one and Richter must, therefore, be regarded as a very remarkable man. In his discovery that the amounts of different metals combining with a given weight of acid combine with a fixed amount of oxygen, he went a step further, anticipating the work of Gay Lussac, and when he established the fact that such metals as iron and mercury have the power of combining with oxygen in several proportions, showing different degrees of oxidation, he was several years ahead of Proust and verged upon the discovery of the law of multiple proportions.

With all his ability to see deeply into the workings of natural phenomena, Richter was not a clear and logical thinker. Wurtz rightly speaks of him as 'the profound but perplexed author of the great discovery of proportionality.' He was confused by his adherence to the illogical phlogistic theories which were becoming each year more untenable. He was further hampered by his determination to give a mathematical foundation to the science of chemistry and to express all chemical changes by formulæ

* Read before N. C. Section, Amer. Chem. Soc., Nov. 9, 1900.

and equations worked out along algebraic lines. It was, doubtless, the presence of these mathematical equations all through his volumes which deterred many chemists from a full and patient examination of them for the kernel of truth which they might contain. The average experimental chemist is not much attracted by abstruse mathematical speculations.

Later chemists commenting upon his work have made some mention of the mathematical regularities observed by him and this led me to think that perhaps Richter might have caught some glimpse of the periodic law before the conception of the atom and the atomic theory had entered into chemistry. To investigate this question it was necessary to examine Richter's writings and I was fortunate enough to secure the use of a copy of his Stöchyometrie through the courtesy of the librarian of the American Academy of Arts and Sciences.

It is of interest, first, to see how near an approach Richter made to the conception of atoms. In the preface to Volume I. the question of solution is discussed and the statement is made that "the chemist cannot boast of being able in any manner to divide a body up into the smallest parts because matter can be thought of as infinitely divisible." From many passages one may judge, however, that he held to the corpusclar view of matter, namely that it was composed of certain very small, discrete particles, which were, however, conceivably further divisible. Thus in giving the various definitions of elements he says that to one chemist the word meant the simplest indestructible substance, the subtlest material which the creator had created for the formation of all other bodies; to another it meant such materials as could not be decomposed into dissimilar particles and in which no component particles could be recognized. For himself he prefers to divorce the word from all connection with primal matter, or Urstoffe, and to make use of it simply as a part of the chemical technology, attaching to it the meaning of a body undecomposable by any means known to the chemist. Chemistry as an art, according to Richter, consisted in the ability to separate elements from one another and to bring them together as constituents of a new body. Chemistry as a science was something greater, including its theories and fundamental axioms. A chemical element, he says, is one which, without being decomposed into unlike parts, can by mixing with other kinds of matter cloak their peculiar characteristics and bring about others. It is *elementum immediatum* when it cannot be decomposed into unlike parts; *mediatum* when it can be thus decomposed (p. 5 seq.).

Thus, as Richter adds in a footnote, vitriolic acid is an *elementum immediatum*, since no one has been able to decompose it into unlike parts, but sulphur is an *elementum mediatum*, since any one knows that it can be decomposed into vitriolic acid and phlogiston and reformed from these two. This is of interest as showing the degree of knowledge on which he based his reasoning. His corpuscles are called 'Theilganzen,' and in these the force of affinity resides. Thus he states, "to each infinitely small particle of the mass of an element there belongs an infinitely small portion of the chemically-attracting force of affinity" (p. 123).

The part of Richter's work which appears to refer most nearly to the periodic system is found in his second volume on page vi of the preface. He refers to the fact that the supposition had already been made in a paper on the 'Newer Objects of Chemistry, especially the recently discovered half-metal Uranium,' that the affinities of many chemical elements towards any single one might be in a definite progression. This supposition, says Richter, has already in the case of four quantitative series been raised to the dignity of an incontrovertible rule. The tables of masses form arithmetical progressions and the affinities of the elements which belong to the series, proceed also, in so far as they are not disturbed by the indwelling elementary fire, in the order of the masses. Besides one is in position to see the probability of many homogeneous elements present in nature. Also the doubled affinities proceed in arithmetical progression and with careful observations one can scarce resist the thought that *the entire chemical system consists of similar progressions.*

It is well to examine a series given by Richter to get more fully at his meaning. Thus in the same volume, page 28, he gives the masses of the alkaline earths which neutralize 1,000 parts of hydrochloric acid.

Magnesia $734 = a$
Lime $858 = a + b$ $(734 + 124\frac{1}{2} = 858\frac{1}{2})$
Alumina $1,107 = a + 3b$ $(734 + 3 \times 124\frac{1}{2} = 1,107\frac{1}{2})$
$= a + 5b$ $(734 + 5 \times 124\frac{1}{2} = 1,356\frac{1}{2})$
$= a + 7b$ $(734 + 5 \times 124\frac{1}{2} = 1,605\frac{1}{2})$,
etc.
Baryta $3,099 = a + 19b$ $(734 + 19 \times 124\frac{1}{2} = 3,099\frac{1}{2})$

Similar series are given for the alkalies and alkaline earths with the different acids. Again these tables are compared with one another and thus was brought out the law of proportionality. One of the most remarkable regularities is obtained by examining the differences in the masses in such a series made up of observed combining numbers of known elements and interpolated combining numbers of hypothetical elements. Thus (p. 38):

$616 - 526 = 90 = 1 \times 90$
$796 - 526 = 270 = 3 \times 90$
$973 - 526 = 447 = 5 \times 90 - 3$
$1,152 - 526 = 626 = 7 \times 90 - 4$
$1,330 - 526 = 804 = 9 \times 90 - 6$
etc., etc.

Of course, it is readily seen that all these regularities are more in the line of the triads of Döbereiner or the later work of Dumas than the periodic system. But a close examination reveals something more —a really deeper insight into the nature of the elements which is marvellous when one considers that Richter was dealing with compounds not elements, and with combining numbers and not atomic weights. First, one must note his statement of the belief that 'the entire chemical system consists of like progressions.' To his mind the elements formed a system correlated and made up of progressions. This is, of course, not the ascending series of de Chancourtois and Newlands, but it seems to me a position much nearer to it than was reached by any chemist for more than half a century afterwards.

Again, in other portions of this volume Richter speaks of the necessity of deducing quality from quantity and vice versa. Thus he points out that the series of masses mentioned as forming arithmetical progressions are really series of affinities also, and the relative affinities might be deduced from the relative masses. Much space is given also to the effort at tracing relationships of the specific gravities. While it cannot be positively stated that Richter foresaw that important part of the periodic law that the properties of the elements are dependent upon the weights, he seems at least to have been possessed with the idea that what he called the masses of the elements had something to do with what he considered the qualities, or that they progressed similarly. And that they in the main progress similarly is about all that we know with regard to them at the present day.

I acknowledge that there is some difficulty in sifting out Richter's full meaning from the mass of mathematical calculation and one must be careful to avoid reading into his work the thought of later years. It is not strange that the tedium of following such involved calculations and speculations as his should have deterred his contemporaries from following his trend of thought or paying much attention to him. It cannot be claimed that he preceded Dalton in his conception of the Atomic Theory, but Richter belongs to the number of the great original thinkers of chemistry and it is time that greater justice be done him.

F. P. Venable.

VERTEBRAL FORMULA OF DIPLODOCUS (MARSH).

The splendid skeleton of Diplodocus, discovered in the Como Bluffs of Wyoming by the American Museum party of 1897, has enabled Professor Osborn to very materially increase our knowledge of the osteology of that genus.* Interesting and unique as was the material that formed the basis of Professor Osborn's memoir, it nevertheless left many questions unsettled concerning the osteology of Diplodocus. In 1899 a second skeleton was discovered in the Dinosaur beds of the Upper Jurassic, near Sheep Creek, in Albany County, Wyoming, by Dr. J. L. Wortman, while engaged as Curator of Vertebrate Paleontology of this Museum, in exploring the fossil-bearing horizons of that region.

The second skeleton of Diplodocus was very carefully exhumed under the skillful direction of Dr. Wortman, and has since been entirely freed from the matrix and temporarily mounted by Mr. A. S. Coggeshall, Chief Preparator in the Department of Paleontology.

Now that this material is available for study, it proves to supplement in a remarkable manner the skeleton belonging to the American Museum. A detailed description of our material will be given in a paper by the writer which it is proposed to have appear among the memoirs of this institution. In the present note only the vertebral column will be considered, and no attempt will be made to describe this in detail, but rather to correct some errors concerning the vertebral formula of Diplodocus as given by Osborn in his memoir cited above, and by Dr. W. J. Holland, in a subsequent paper entitled 'The Vertebral Formula in Diplodocus, Marsh,' published in this Journal, May 25, 1900, and based upon the material now under discussion.

About 45 feet (14 meters) of the vertebral column is preserved in our specimen. When discovered the vertebræ did not lie in a connected and unbroken series, yet there can be little doubt that they all pertain to the same individual, and they have been mounted as a continuous series commencing with the axis and ending with the twelfth caudal. In all 41 vertebræ are represented, including 14 cervicals (all but the atlas), 11 dorsals, 4 sacrals and 12 caudals.

Assuming that no vertebræ are missing from our series the vertebral formula of Diplodocus should now be written as follows:

Cervicals, 15.
Dorsals, 11.
Sacrals, 4.
Caudals, 37, as estimated by Osborn, not 35, as attributed to him by Holland.

The above vertebral formula will be seen to differ from that given by Holland, the latest contributor on this subject, as follows:

1. The number of cervicals is at least 15.

2. There are 11 dorsals instead of 10, as fixed by Holland, who mistook the first presacral of Osborn for a sacral.

There are 4 sacrals, as given by Osborn and Holland, while the number of caudals is still placed at 37, as estimated by Osborn. Of the caudals, only the 12 anterior are preserved in our skeleton, and the second and third of these have coossified centra.

In placing the number of dorsals at 11, I am assuming that Osborn is right in considering the first vertebra with a free spine,

* See 'A Skeleton of Diplodocus,' Part V., Vol. I., Mem. Am. Mus. Nat. Hist., pp. 191–214

anterior to the 3 sacral vertebræ with coalesced spines as a dorsal rather than a sacral. I also assume that we have represented in our skeleton the complete dorsal series, but of this we cannot be absolutely certain, since the vertebræ were not found in an articulated series. Unfortunately no diagram was made, at the time of exhuming the remains, showing the relative position of each of the vertebræ in the quarry. Early last spring, at the request of the writer, Mr. W. H. Reed (who assisted in unearthing the skeleton), while again on the ground, made a diagram of the quarry, showing the relative positions, as he remembered them, of the various bones of the skeleton. This diagram shows two rather marked breaks in the vertebral column, and I may add that a close examination of the dorsal series as now mounted seems to indicate that there are two or more missing vertebræ. This is especially noticeable between presacrals 7 and 8 or dorsals 5 and 4. In presacral 7, the capitular facet is situated well up, on the side of the neural arch, while in the presacral immediately anterior it extends well down on the centrum. Not only does this sudden shifting of the position of this articular surface seem to indicate that there are wanting at this point in the series one or more vertebræ, but I may add that according to Professor Osborn's figures the actual position of the capitular facet on presacral 8 is much higher than that occupied by that facet on the vertebra that has been assigned to the same position in our series, thus indicating a more anterior position for this vertebra, and consequently a greater number of dorsal vertebræ than has been given above. Since the vertebræ in the American Museum series were all found interarticulated by their zygapophyses, there can be no question of the position of each dorsal in that series, relative to the sacrum. There also appears to be a break in our series between the last cervical and the first dorsal, and it is barely possible that the first true dorsal or last cervical is wanting in our series. From the above it will be seen that there is a possibility that when the actual number of dorsal vertebræ in Diplodocus is definitely known, it will be somewhat greater than that given here, and that Professor Marsh was perhaps not far wrong when he figured it at 14.

Should the first vertebra anterior to the three sacral vertebræ with coalesced spines come eventually to be considered as a sacral, rather than a dorsal, the sacrum would then have to be considered as composed of 5 vertebræ instead of 4, as has been done by Osborn, Holland and the present writer. If we consider this vertebra as a modified dorsal and not a sacral, there would seem to be no good reason why we should not consider the fourth sacral, which also has a free spine, as a modified caudal, since the centra of each are firmly ankylosed with the sacrals bearing coössified spines. This interpretation would reduce the number of true sacrals to 3, as was originally given by Marsh.

Another marked character brought out by our skeleton is the great absolute and proportionate length of the cervical region in Diplodocus. Osborn has given the known and estimated lengths of the vertebral column as follows:

Caudals, 30 feet.
Sacrals, 2 feet.
Dorsals (estimated) 12 feet.
Cervicals (estimated) 12 feet.
Skull, 2 feet.

The length of the cervical series alone in our skeleton is somewhat over 21 feet; and the atlas is yet to be found. The dorsal series is somewhat shorter than that estimated by Osborn.

The main points that it is desired to emphasize are:

1. The number of cervical vertebræ in Diplodocus is definitely fixed at at least 15.

2. There are at least 11 dorsal vertebræ, perhaps two or three more.

3. The great comparative and absolute length (21 feet) of the cervical series, a striking analogy to that exhibited in the struthious birds.

4. The actual number of dorsals in Diplodocus seems to be 11, but cannot be definitely determined from our skeleton, and we must await further discoveries for its solution.

J. B. Hatcher.
Carnegie Museum.

PLANT GEOGRAPHY OF NORTH AMERICA. III.

THE LOWER AUSTRAL ELEMENT IN THE FLORA OF THE SOUTHERN APPALACHIAN REGION. A PRELIMINARY NOTE.*

In that portion of the United States which lies south of the Potomac and Ohio Rivers and east of the Mississippi, three principal orographical areas are readily distinguishable. These are generally known as the Pine Barren or Low Country (Coastal Plain), the Piedmont or Middle Country and the Mountains or Upper Country. Their respective characteristics—climatic, physiographical and biological—have been so often described in popular and scientific writings that to enumerate them here would be superfluous. So obvious are their distinguishing features, that no observant traveler fails to take note of them as he crosses the southeastern States.

The altitudinal limits of these three areas coincide roughly with those of three great continental life zones, *i. e.*, the Lower Austral Zone in its humid or Austro-riparian Area; the Carolinian Area of the Upper Austral, and the Alleghanian Area of the Transition Zone.*

The Coastal Plain, presenting but scant diversity in its orography, is occupied almost exclusively by a Lower Austral fauna and flora. In the Piedmont Region the surface of the country is less uniform and we encounter within its general boundaries many scattered localities where conditions permit the occurrence of Lower Austral or of Transition colonies amid the prevailing Carolinian life. But in the Mountain Region there exists such a variety of conditions that all the life zones from Lower Austral to Hudsonian are represented in places, although their limits are here very ill-defined, and the precise location of them presents many intricate problems.

Thus along the higher Smoky Mountains and the Blue Ridge, we find a typically Canadian forest of firs (*Abies Fraseri*), accompanied by such trees and shrubs as the yellow birch (*Betula lutea*), mountain ash (*Sorbus americana*), mountain maple (*Acer spicatum*), red elder (*Sambucus racemosa*) and wild red cherry (*Prunus pennsylvanica*). Other characteristically Canadian species like the striped maple (*Acer pennsylvanicum*), hemlock (*Tsuga canadensis*), white pine (*Pinus Strobus*) and the arbor vitæ (*Thuya occidentalis*) descend to much lower elevations (900 meters or less). Along the crest of the highest mountains of this region, usually at an altitude of 1,800 meters (6,000 feet) or upwards, a sparse Hudsonian flora is encountered. The green alder (*Alnus viridis*), and, of herbs, *Arenaria groenlandica*,

* In the matter of nomenclatnre, in this paper, I have followed that employed by Britton and Brown in their 'Illustrated Flora of the Northern United States and Canada.' Bnt in order to be understood by readers who are not familiar with that nomenclature, I have added, in parentheses, the synonym generally cnrrent among American botanists before the adoption of the 'Rochester Code,' wherever a change has been made under that code.

* For a definition and description of these zones see Merriam in *Nat. Geogr. Mag.*, 6 : pp. 220–238, Maps, 1894. Also, 'Life Zones and Crop Zones of the United States' ; Bull. Div. Biol. Survey, U. S. Dept. Agric., 10 : pp. 18–33, Map, 1898 (with a correction of the temperature data), in Science 9 : No. 212, p. 116 (1899).

Potentilla tridentata, and *Trisetum subspicatum*, may be regarded as typical of this zone.

By far the greatest part of the surface of the mountain region is covered with an Alleghanian (Transition) flora. To this zone may be reckoned such woody species as the cherry birch (*Betula lenta*), species of Magnolia (*Umbrella*, *acuminata*, *Fraseri*), sugar maple (*Acer saccharum*), the big laurel (*Rhododendron maximum*), mountain laurel (*Kalmia latifolia*), etc. Mingled with these are black walnut (*Juglans nigra*), tulip tree (*Liriodendron tulipifera*), shag-bark and mocker-nut hickories (*Hicoria ovata* or *Carya alba* and *H. alba* or *Carya tomentosa*), white and chestnut oaks (*Quercus alba* and *Q. Prinus*), holly (*Ilex opaca*), chestnut (*Castanea dentata*), witch hazel (*Hamamelis virginiana*) and beech (*Fagus americana*, or *ferruginea*) which are perhaps somewhat more characteristic of the Alleghanian flora, but are hardly less abundant in the Carolinian.

The lower slopes of the mountains and the valleys between are largely occupied by extensions of the Upper Austral (Carolinian) Zone. Very characteristic species, especially along the streams, are buttonwood (*Platanus occidentalis*), river birch (*Betula nigra*), linden (*Tilia heterophylla*), hackberry (*Celtis occidentalis*), sweet gum (*Liquidambar styraciflua*), red mulberry (*Morus rubra*), sassafras (*Sassafras officinale*), persimmon (*Diospyros virginiana*), tupelo (*Nyssa sylvatica*), and species of pine, notably the scrub pine (*P. virginiana* or *inops*), and the yellow pine (*P. echinata* or *mitis*). Usually intermingled with these are numerous partially Transition species, *e. g.*, beech and American elm (*Ulmus americana*). The dried summer slopes add to this list such species as the chinquapin (*Castanea pumila*), sourwood (*Oxydendrum arboreum*) and black-jack oak (*Quercus marylandica* or *nigra*).*

Growing amid the often very large body of Carolinian forms, thus established in the region we are considering, there occurs a much smaller number of species which are most abundant in and characteristic of the Austro-riparian area of the Lower Austral Zone. Only two or three trees and comparatively few shrubs which are distinctly of the Lower rather than the Upper Austral Zone extend into the mountain region. But of herbs the number is a respectable one. Over one hundred species which are most abundant and most widely distributed in the Austro-riparian area are known to occur in the mountains at an elevation of 300 meters (1,000 feet) or more.

A faint indication of this Lower Austral element is perceptible as far north as West Virginia and southeastern Kentucky; while, on the mostly isolated granitic outcrops in northern central Georgia and northern Alabama, of which Stone Mountain is a type, it is so extensive as somewhat to obscure the mainly Carolinian character of the flora. In the former case the Austro-riparian forms are few and unimportant. In the latter instance the stations are so inferior in elevation, are so nearly isolated from the principal mountain chains and are so close to the main borders of the Austro-riparian area as to possess small significance as extensions of that area. Hence we had best confine ourselves here chiefly to that portion of the Appalachian Region which falls within the limits of North Carolina and Tennessee. Here we find some of the highest elevations of eastern North America; and therefore we are justified in regarding as of peculiar interest the presence in their neighborhood of numerous essentially Lower Austral forms of plant life.

It may be well to limit still further the scope of the present investigation by omitting from discussion species which do not reach

*I have purposely omitted from the above lists such species as are endemic in the Southern Appalachian Region, as being less suitable to indicate the general zonal relationships.

an elevation of 300 meters (1,000 feet). Below that altitude, the flora of the Southern Appalachian Region is mainly Carolinian, and the presence in its midst of numerous Austro-riparian forms would be expected. The occurrence of Lower Austral species at higher elevations, in the midst of a chiefly Transition flora is the phenomenon which demands our attention.*

Some of the species occurring on Lookout Mountain, but not reported from other stations in the mountains, *e. g.*, *Pinus Taeda*, *Cebatha carolina* (*Cocculus carolinus*), *Vaccinium arboreum* and *Spigelia marilandica*, also extend farther up the Tennessee Valley. Finally a considerable number of Lower Austral species, which are encountered rather rarely among the mountains, are frequent or common along the Tennessee River, near Knoxville (elevation 270 meters). We may cite:

Poa Chapmaniana.
Arundinaria macrosperma.
Arundinaria tecta.
Yucca filamentosa.
Agave virginica.
Centrosema virginiana.
Hypericum densiflorum.
Hypericum virgatum.
Callicarpa americana.
Aster concolor.
Tetragonetheca helianthoides
Helenium nudiflorum.

The Austro-riparian species which are met with in the region thus defined do not always grow scatteringly among Carolinian forms. Not infrequently, in peculiarly favorable localities, such as the diminutive pine barrens which cover sandy river bottoms and the dry, sunny lower slopes of the hills, they occur in numbers so pronounced that a botanist suddenly set down amongst them might be puzzled for a moment as to his zonal whereabouts. Yet a two or three hours' walk would take him through a typical Transition vegetation into that which is almost wholly Canadian. Two colonies of this character with which I am personally familiar are worthy of more detailed description.

Along the French Broad River below Paint Rock, North Carolina, and just within the limits of Tennessee, the stream is bordered by limited strips of flat land, which are mostly covered by a small growth of yellow pine (*Pinus echinata* or *mitis*), with frequent clearings among the trees. The altitude of the river-banks is here from 345 to 360 meters (1,150 to 1,200 feet) above the sea. In these groves the herbaceous flora is, as it were, a bit of the carpet of the coastwise pine-barrens, which has been laid down intact along the banks of a mountain stream. The following list of species, all of which are abundantly represented, indicates the character of this flora. It will be noticed that Gramineæ, Leguminosæ and Compositæ contribute a very large proportion.

Erianthus alopecuroides.
Andropogon argyræus.
Chrysopogon nutans var. *Linnæanus.*
Sporobolus asper.
Danthonia sericea.
Gymnopogon ambiguus (*G. racemosus*).
Triodia Chapmani.
Cratægus uniflora (*C. parvifolia*).
Morongia angustata (*Schrankia angustata*).
Cracca spicata (*Tephrosia spicata*).
Stylosanthes riparia.
Rhynchosia erecta.
Croton glandulosus.

* Naturally the extent of Lower Austral invasion is greatest along the water-courses of the region. Thus, in the valley of East Tennessee, which is in much of its length fully one hundred miles wide between the Great Smokies southeastward and the Cumberland Range towards the north and west, there occur at an elevation of 240 to 270 meters not a few typically Austro-riparian species which apparently do not penetrate those smaller mountain valleys which are situated above 300 meters. Examples are:

Agrostis Elliottiana.
Ampelopsis cordata (*Cissus Ampelopsis*).
Cynoctonum Mitreola (*Mitreola petiolata*).
Nemophila microcalyx.
Lithospermum tuberosum.
Diapedium brachiatum (*Dicliptera brachiata*).
Eupatorium incarnatum.

Vitis rotundifolia.
Hypericum Drumondii.
Bignonia crucigera (*B. capreolata*).
Elephantopus tomentosus.
Eupatorium aromaticum.
Chrysopsis graminifolia.
Silphium Asteriscus.
Silphium compositum.

Another noteworthy Austro-riparian colony occurs at a mean elevation of about 300 meters (1,000 feet), in the cañon-like valley of the Hiwassee River, in extreme southeastern Tennessee. Here the number of almost purely Lower Austral Gramineæ is particularly striking. Some of the most important species are:

Erianthus alopecuroides.
Erianthus contortus.
Erianthus brevibarbis.
Andropogon argyræus.
Andropogon Elliottii.
Paspalum purpurascens.
Panicum gibbum.
Panicum viscidum.
Danthonia sericea.
Uniola longifolia.
Poa Chapmaniana.
Decumaria barbara.
Baptisia alba.
Aralia spinosa.
Ptilimnium capillaceum (*Discopleura capillacea*).
Phlox amœna.
Melothria pendula.
Lacinaria graminifolia (*Liatris graminifolia*).
Helianthus angustifolius.

Lookout Mountain, especially near its southwestern end, in Alabama, harbors a notable colony of Lower Austral plants; but the precise altitudes at which most of the species occur are not known to me. Some of them which have not been reported from other stations in the mountains are:

*Pinus Tæda.**
Xyris communis.
Asimina parviflora.
Cebatha carolina (*Cocculus carolinus*).
Sarracenia flava (var. *oreophila*).
Crotonopsis linearis.
*Berchemia scandens.**
Vaccinium arboreum.
*Gelsemium sempervirens.**
Spigelia marilandica.
Yatesia læte-virens (*Gatesia laete-virens*).*
Chondrophora virgata (*Bigelovia nudata virgata*).

These three localities are but a few among many which could have been selected to illustrate the extension of Lower Austral species beyond the normal altitudinal limits of their zone. Hardly a warm lower slope or a sunny valley in the mountains but shelters a greater or less number of them. The mapping of these colonies is one of the nicest and one of the most interesting pieces of work that awaits the future investigator of local floras in this territory, for it goes without saying that it is impossible to indicate them on any general map of the Southern Appalachian region.

Let us now examine more in detail the composition of the flora which occupies these outposts of the Lower Austral Zone. A category which may be eliminated at the outset embraces those species which have been introduced into the mountains by the direct or indirect agency of man. Here belong a number of, for the most part, indigenous weeds which are common in waste and cultivated land in the low country of the southeastern United States, and which have penetrated the Appalachian region chiefly along the railways, *e. g.*:

Cynodon Dactylon.
Commelina nudiflora.
Croton glandulosus.
Croton monanthogynos.
Passiflora incarnata.
Polypremum procumbens.
Sitilias caroliniana (*Pyrrhopappus carolinianus*).
Eupatorium capillifolium (*E. fœniculaceum*).
Helenium tenuifolium.

Of the lower Austral species whose occurrence in the Appalachian region can not be referred to the agency of man, the greater number—about sixty per cent.—range elsewhere beyond the limits of the

* Occurrence on Lookout Mountain needs confirmation.

Lower Austral Zone as generally recognized.* In other words they have a latitudinal, as well as altitudinal, extra-zonal extension. Yet because of their much wider distribution and greater abundance within the proper limits of that zone, they are to be regarded as essentially Lower Austral species.

This majority becomes, however, a small minority and the percentage is reduced to about twenty-five, if we exclude species whose northward extra-zonal range extends only as far as eastern Maryland, Delaware or southern New Jersey. When we consider how largely the Carolinian flora of this latter section is diluted with Austro-riparian forms, almost to the obscuring of its true zonal relationship, we can not attach very great weight to the occurrence here of any particular Lower Austral species. Or, better expressed, the extension of such a species into the heart of the Appalachian region must be regarded as more significant than its occurrence in the Coastal Plain no farther north than southern New Jersey.

Of that large minority of Lower Austral species of the Appalachian region which exceed the general zonal limits in altitude but not in latitude, the following is a preliminary and, doubtless, very incomplete list:

Erianthus alopecuroides.
Erianthus brevibarbis.
Erianthus contortus.
Chrysopogon nutans var. *Linnæanus.*
Paspalum longipedunculatum.
Paspalam purpurascens.
Panicum gibbum.
Panicum longipedunculatum.
Triodia Chapmani.
Uniola longifolia.
Arundinaria macrosperma.
Cyperus echinatus (*C. Baldwinii.*)
Lilium carolinanum.
Ulmus alata.
Asimina parviflora.
Cebatha carolina (*Cocculus*).
Sarracenia flava (var. *oreophila*).
Parnassia grandifolia.
Decumaria barbara.
Morongia angustata (*Schrankia*).
Baptisia alba.
Psoralea pedunculata.
*Berchemia scandens.**
Vaccinium arboreum.
*Gelsemium sempervirens.**
Phlox amœna.
Callicarpa americana.
Yatesia laete-virens (*Gatesia*).*
Melothria pendula.
Elephantopus tomentosus.
Chondrophora virgata (*Bigelovia*).
Aster purpuratus (*A. virgatus*).
Pluchea petiolata.
Antennaria solitaria Rydberg (*A. plantaginifolia* var. *monocephala* Torr. & Gray).
Silphium compositum.
Tetragonetheca helianthoides.
Coreopsis auriculata.
Coreopsis major (*C. senifolia*).
Helenium nudiflorum.

The presence, at an elevation of 300 meters or more, of this considerable number of Austro-riparian species which nowhere else venture beyond the limits of their life zone, is, on the whole, the most noteworthy fact in regard to the Lower Austral element in the highland flora of the Southern States. Species of this category would appear to possess less general tendency to exceed their zonal limits than do those which range farther northward, and this enhances the interest of their occurrence in the mountains.

We now come to the difficult question of the probable past history of the Lower Austral plants which occur to-day in the Appalachian region. Are they relics of a flora once more widely distributed there, or are they the vanguard of an invading army from lower altitudes and latitudes? Al-

* The Austro-riparian Area, as defined by Merriam in various papers (recently in Bull. 10, Div. Biol. Survey, U. S. Dept. Agric.) reaches its most northern limits at the mouth of Chesapeake Bay; in extreme southwestern Indiana, southern Illinois and southeastern Missouri; and in southeastern Kansas.

* Occurrence in the Appalachian region as above defined somewhat doubtful.

though the answer must be largely speculative, it is hardly a pure assumption that both cases may be true in part. In studying this floral element, one soon reaches the conclusion that it comprises two categories of species which are markedly different not only in their systematic relationships, present distribution in the region and probable past history, but even, to a considerable degree, in their ecological constitution. But, in some cases, it is almost impossible to decide to which of the two groups a given species should be referred.

1. Plants of probably neotropical origin which have in all likelihood made their first appearance in the Appalachian region in geologically very modern times, probably after the close of the so-called Glacial Epoch. The following list embraces species which, from their distribution elsewhere, or from their affinities, are most likely to have had this history :*

Erianthus alopecuroides.
Erianthus brevibarbis.
Erianthus contortus.
Andropogon argyræus.
Andropogon Elliottii.
Chrysopogon nutans var. *Linnæanus.*
Paspalum longipedunculatum.
Paspalum purpuracens.
Panicum gibbum.
Panicum angustifolium.
Panicum longipedunculatum.
Panicum viscidum.
Muhlenbergia capillaris.
Sporobolus asper.
Gymnopogon ambiguus.
Triodia Chapmani.
Cyperus echinatus (*C. Baldwinii*).
Kyllinga pumila.
Xyris communis.
Commelina erecta.
Commelina hirtella.
Yucca filamentosa.
Agave virginica.
Pogonia divaricata.
Phoradendron flavescens.
Asimina parviflora.
Cebatha carolina (*Cocculus*).
Morongia angustata (*Schrankia*).
Cracca spicata (*Tephrosia*).
Stylosanthes riparia.
Bradburya virginiana (*Centrosema*).
Clitoria mariana.
Rhynchosia erecta.
Crotonopsis linearis.
Ascyrum stans.
Hypericum densiflorum.
Hypericum Drummondii.
Hypericum virgatum.
Rhexia mariana.
Jussiæa decurrens.
Gelsemium sempervirens.
Cynoctonum Mitreola (*Mitreola petiolata*).
Spigelia marilandica.
Callicarpa americana.
Gratiola sphærocarpa.
Gratiola viscosa.
Bignonia crucigera (*B. capreolata*).
Yatesia læte-virens (*Gatesia*).
Diodia virginiana.
Melothria pendula.
Elephantopus tomentosus.
Eupatorium album.
Eupatorium aromaticum.
Lacinaria graminifolia (*Liatris*).
Chrysopsis graminifolia.
Chondrophora virgata.
Pluchea petiolata.
Silphium Asteriscus.
Silphium compositum.
Tetragonotheca helianthoides.
Helianthus angustifolius.
Helianthus atrorubens.
Coreopsis major (*C. senifolia*).
Coreopsis auriculata.
Marshallia lanceolata var. *platyphylla.*
Helenium nudiflorum.

By far the greater number of species in the above list belong to groups, whether genera, tribes or families, which are chiefly tropical in their present distribution. Thus of the three most largely represented families, the Gramineæ belong chiefly to the tribes Andropogoneæ and Paniceæ; the Leguminosæ to Mimosæ and Phaseolæ; and the Compositæ to Eupatoriæ and Helianthoideæ. This category is furthermore remarkable in consisting almost entirely of herbaceous species. Most of them are of distinctly xerophytic structure, loving a dry sandy soil and much light and heat.

2. Plants, probably not of neotropical origin, which are, in several cases, probably the more or less modified descendants of that characteristic flora which in later Eocene or in Miocene time extended to high northern latitudes, also occupying the mountainous parts of what is now the North Temperate Zone.* Of this category, the number of identical species occurring both in the Coastal Plain and in the Appalachian region is notably smaller than in the first group. To be reckoned here, with more or less confidence, are:

Danthonia sericea.
Uniola gracilis.
Uniola longifolia.
Poa Chapmaniana.
Arundinaria macrosperma (?).
Arundinaria tecta (?)
Lilium carolinanum.
Ulmus alata.
Parnassia grandifolia.
Decumaria barbara.
Itea virginica.
Cratægus uniflora.
Cratægus rotundifolia.
Berchemia scandens.
Ampelopsis cordata.
Vitis rotundifolia.
Aralia spinosa.
Dendrium buxifolium (*Leiophyllum*).
Leucothoë racemosa.
Oxydendrum arboreum.
Gaylussacia dumosa.
Vaccinium arboreum.
Symplocos tinctoria.
Chionanthus virginica.
Antennaria solitaria.

Most of the species, as well as many of the genera, comprised in this second category are characteristic neither of tropical nor of high northern regions. They belong in great part to groups which are most largely represented at present in the mountainous parts of the Warm Belt of the Northern Temperate Zone, in both the Eastern and Western Hemispheres. Some of them, however, are of floral types which are to-day most highly developed in the tropics. Such are the species of *Arundinaria*, *Berchemia scandens*, *Ampelopsis cordata*, *Aralia spinosa* and *Symplocos tinctoria*. Yet the groups to which several or all of these species belong, formerly had a much wider extra-tropical distribution than is now the case. A few plants of this category, *i. e.*, the species of *Poa*, *Parnassia* and *Antennaria* belong to genera of mainly boreal and alpine distribution.

To be considered in connection with this second category of the Lower Austral species which occur both within the main limits of the Austro-riparian area and in the mountains, is a very significant group of genera which are represented in eastern North America by two closely allied species or group of species, one in the Coastal Plain, the other in the Appalachian region.

With the exception of *Clethra* (which is largely tropical) all these genera, like many of those represented by species of the second category, have their present center of distribution in the warmer part of the North Temperate Zone. This may be said also of the larger groups to which many of them belong, *e. g.*, the families Calycanthaceæ, Sarraceniaceæ, Hamamelidaceæ and Monotropaceæ, and the tribes Hydrangeæ of Saxifragaceæ and Andromedeæ of Ericaceæ. Some of them are known to belong to floral types which were very widely distributed in the Northern Hemisphere during the earlier part of the Tertiary, in not a few cases ranging as far north as Greenland and Alaska; and we may be permitted to con-

*According to De Saporta et Marion (Recherches sur les végétanx fossiles de Meximieux; Archiv. Mus. Hist Nat. de Lyon, 1: 304–324 (1875), a vegetation of Magnolia, Lauraceæ, Liqnidambar, Anonaceæ, Ilicaceæ, Liriodendron, etc., occurred on the mountains of southeastern France, at altitudes of 200 to 700 meters, during the Pliocene. That a similar flora flourished contemporaneously in the mountains of eastern North America would seem by no means unlikely. If so, the Pliocene flora of the Appalachian region must have borne considerable resemblance to that which prevails there to-day.

jecture that the ancestors of most of these genera whose actual history is still undisclosed were thus distributed during Miocene time. Very broadly speaking, several of these genera represent groups which appear to be on the wane, as distinguished from the dominant and, one may say, aggressive types of presumably neotropical origin to which the species of the first category chiefly belong.

Genus.	Coastal Plain Species.	Appalachian Species.
Butneria (*Calycanthus*).	*florida*.	*fertilis* (*glauca*).
Sarracenia.	*flava*.	*flava* var. *oreophila*.
Philadelphus.	*grandiflorus*.	*inodorus*.
		hirsutus.
Hydrangea.	*quercifolia*	*radiata*.
		cinerea.
Fothergilla.	*carolina* (*Gardeni*).	*arborescens*.
Stuartia.	*Malachodendron* (*virginica*).	*major*.
Clethra.	*alnifolia*.*	*pentagyna*.
Monotropsis (*Schweinitzia*).	*Reynoldsiæ*.	*acuminata*.
Leucothoë.	*axillaris*.	*odorata*.
	racemosa.*	*Catesbæi*.
Pieris.	*phyllyreifolia*.	*recurva*.
Mohrodendron (*Halesia*).	*dipterum*.	*floribunda*.
	parviflorum.	*carolinum* (*tetraptera*).

In another important respect the second category differs from the first, *i. e.*, in its ecological character. A majority of the species which it comprises are woody plants, shrubs, lianas or trees; and this majority becomes a large one if we take into account the list of representative species just given. The first category, as we have seen, consists almost wholly of herbaceous forms.

A considerable number of species of the second category, notably several of the woody plants with thick, more or less persistent, leaves is essentially xerophytic in structure. But the xerophilous leaf-structure is here in most cases probably a consequence of the long duration of that organ and a protection against winter conditions, rather than an adaptation to the effects of climate and soil during the growing season.

* Ranges beyond the northern limits of the Austro-riparian area.

On the other hand, the number of shade-loving tropophytes or mesophytes is decidedly greater than in the first category. The plants of the second category are more often scattered among Transition and Carolinian vegetation, showing generally little tendency to form well-defined Lower Austral colonies. Finally, they are, on the whole, less characteristic of the Austro-riparian area, as distinguished from the Carolinian area, than are many of the species of our first category.

Having thus segregated the two principal groups of species which constitute the floral element under discussion, are we in a position to draw conclusions as to its past history? The answer must be that it is possible as yet to formulate only broad generalizations which are hardly more than pure hypotheses. The paleontological record, during the period which doubtless witnessed the gradual rearrangement of the plant covering of the Southern Appalachian country in its present form, *i. e.*, from the Pleistocene to the present, is fragmentary in the extreme for the region in question. We can get only glimpses of what may have been the course of events. Here and there a headland can be seen, but the trend of the intervening shore-line is only to be guessed at.

That there is reason to modify the formerly current assumption that extremely low temperatures existed in the Northern Hemisphere during the Glacial Epoch is now urged by not a few authorities.* In a paper which advocates revision of preconceived ideas on this point, Vater † calculates that points in middle Germany which were not distant from the edge of the great Ice Sheet, possessed, during the Glacial Epoch, a mean annual temperature of 4° C., as compared with 10.6° C. at the present day. But even this amount of difference must have wrought great changes in the vegetation, and, if the same ratio obtained in eastern North America, we may well assume that no member of what constitutes to-day the characteristic Austro-riparian flora could have maintained itself in the Appalachian region, during the climax of the Ice Age.* For we must remember that the great glacier made its way southward as far as the present location of Cincinnati, on the Ohio River, and extended to the southern shore of Staten Island.†

We may premise, therefore, with considerable confidence, that any portion of the Lower Austral flora of to-day which may have inhabited the Appalachian region prior to the Pleistocene retreated to lower altitudes and latitudes when the Ice Sheet approached its most southern limit. If we were to maintain, on the other hand, that Lower Austral plants had survived the Glacial Epoch in the Appalachian region, we should be compelled to assume that species which had developed under the mild climatic conditions generally believed to have prevailed, even in high northern latitudes, during Miocene and Pliocene times, later adapted themselves to the considerably lower temperatures prevailing during the comparatively brief Glacial Epoch, and, after the close of that Epoch, readjusted themselves to the warmer temperatures which again held sway.‡

*Thus J. D. Whitney, who goes much farther than most geologists in reaction against previously entertained ideas as to the extent and importance of the Ice Sheet, remarks as follows in his well known paper on 'The Climatic Changes of Later Geological Times' (Contr. to Amer. Geology, Harvard University, Vol. 2, p. 268, 1888): "A general refrigeration of the earth could never have caused that peculiar distribution of snow and ice to which the term Glacial Epoch is commonly applied; and * * * the phenomena in question are entirely compatible with a higher mean temperature than now prevails." Again (p. 321): "We have no right to assume as having existed during the Glacial Epoch a period of intense cold, or even a lower mean temperature than that now prevailing over the earth." And (p. 387): "It is possible to lay aside all idea of explaining the phenomena of the so-called Glacial Epoch, by referring them to the extension of a general or Polar ice-cap over the land of the Northern Hemisphere. * * * The entire body of facts presented brings out most clearly the true condition of things, namely that the Glacial Epoch was a local phenomenon, during the occurrence of which much the larger part of the land-masses of the globe remained climatologically entirely unaffected." This author represents, however, an extreme view, which is rejected by many geologists.

† 'Das Klima der Eiszeit'; Sitzungsber. d. naturw. Gesellsch. Isis in Dresden, 1883, pp. 56, 57 (1884).

* A. C. Seward, in discussing 'Fossil Plants as Tests of Climate' (London, 1892), p. 50, after summing up the evidence *pro* and *con* which has been brought forward to prove that forests could have maintained themselves amid or very near the great glacier, decides against the possibility of such survival. On the other hand, we have no right to assume that a vigorous forest growth may not have continued to flourish in the greater part of the Appalachian region, at least at low elevations, throughout the Glacial Epoch. For, as the same author remarks, pines and even tree ferns thrive to-day at the very edge of the terminal moraines of New Zealand glaciers; while, in Alaska, some glaciers (notably the Malaspina) are largely covered with spruce, alder and other trees.

† The area supposed to have been covered by the Ice Sheet in North America has been mapped by Professor T. C. Chamberlin; 7th Ann. Rep. U. S. Geol. Survey, pl. 8 (1888).

‡ It will be objected that it is not always safe to argue from the present requirements of organisms (especially of genera and still larger groups), the

The difficulty of such an assumption is increased by the fact that some of the forms belonging to our second category have apparently undergone little modification since Pliocene times; and this may well be true of many of them whose past history is still unknown. To the average mind, the alternative hypothesis, that of an extensive migration of the less resistant species from the mountains to the warmer lowlands, is decidedly more thinkable.

As the Ice Sheet began to recede, and the climate of the Appalachian Region became gradually milder, approaching its present character, those species which had resided in the Appalachian Region before the Pleistocene, would have gradually returned thither; but as the climate of to-day is probably considerably colder than that of the Pliocene, it is to be presumed that this floral element now occurs at a lower altitude than that at which it flourished in pre-Glacial times. It may be assumed, furthermore, that the neo-tropical forms which constitute our first category, then began to make their way, for the first time, into the Appalachian Region.

To account for the presence to-day of representative species of certain genera (*e. g.*, *Stuartia*, *Fothergilla*) in the mountains and in the Coastal Plain, respectively, it is conceivable that after the final retreat of the great glacier, the increasing heat of the lowlands induced in some individuals of a single ancestral species, which had sought refuge there during the Ice Age, changes of physiological constitution and of structure which fitted them to endure a warmer climate than that to which they had previously been accustomed. Other individuals having gradually made their way to higher elevations on the heels of the retreating Boreal flora, settled finally in the valleys and on the lower slopes of the mountains, where they have remained up to the present day, perhaps with little variation from the Pliocene form.

If we assume, on the other hand, that forms contained in our list of representative species were enabled to survive the Glacial Epoch without migrating, *in toto*, from the Appalachian Region, an alternative hypothesis becomes possible.

In that case it may be conceived that while some individuals of each hypothetical Pliocene ancestral species maintained themselves in well-sheltered situations and were not forced to a change of abode, others escaped the changing environment by a gradual retreat into the warmer lowlands. The individuals which remained in the mountains were the direct ancestors of the present Appalachian species; while those which migrated and later accustomed themselves in the Coastal Plain to the increasing temperatures that ensued upon the close of the Glacial Epoch, gave rise to the Austro-riparian species that attract our attention to-day because of their close resemblance to Appalachian forms.*

It is true that this theory leaves unexplained the occurrence, both in mountains and plain, of identical species of the second

climatic conditions to which they have previously been adapted. This point is well brought out by H. von Ihering in a paper on 'Die neotropische Tropengebeit und seine Geschichte' (Engler Bot. Jahrb., vol. 17, Beiblatt 42, 1893). It is easily conceivable, for example, that vegetation as a whole has been accustoming itself, during long ages, to gradually decreasing heat. But, in the case which we are here considering, this objection cannot be allowed much weight, as the climatic changes have been more or less oscillatory, rather than progressive and have taken place within a (geologically speaking) comparatively brief period.

* It is not impossible that in some of these cases of representative species, differentiation of the allied forms may have taken place before the advent of the Glacial Epoch. But in most instances the relationship is so extremely close that we need not assume for them an older origin, especially as no other convenient hypothesis offers to account for their present distribution.

category, including such woody plants as *Decumaria*, *Itea*, *Callicarpa*, *Oxydendrum*, *Aralia spinosa*, *Vitis rotundifolia*, etc. A similar case is the presence of *Azalia viscosa*, an essentially Coastal Plain species, here and there in the mountains along with its mountain analogue, *A. arborescens*. *Leucothoë racemosa*, abundant in the swamps of the seaboard, is also found occasionally along highland streams, while a closely related and very similar species, *L. recurva*, is much more abundant in the mountains, to which it is confined. These are cases where the differentiation in distribution of corresponding forms, one in the Coastal Plain, and another in the Appalachian region, is either incomplete or has not taken place at all. But as no fact in biology is better known than the capacity of some species to endure a wide range of physical conditions, while others are fatally sensitive to comparatively slight differences of environment, this difficulty is not an insuperable one.

The initial appearance in the mountains of species of the first category, *i. e.*, those of presumably neotropical origin, was probably somewhat subsequent to the return thither of the Miocene Boreal forms of the second category, for most of the former require decidedly higher temperatures than many of the latter. But we know little of the history of such groups as are chiefly represented in this category and which make up a large part of the modern tropical American flora, *i. e.*, the above mentioned tribes of Gramineæ, Leguminosæ and Compositæ. Hence we must content ourselves with assuming that these species did not exist in the Appalachian region prior to recent geologic time, and that they constitute the most modern element of its flora.

It is more than probable that the hypothesis just outlined is very incomplete as to details and will be found not to account for all the phenomena. Instead of the comparatively simple progression of events which it premises, the fact is pretty well established that there was more than one advance and recession of the Ice Sheet, and that the mutations of the flora have been correspondingly intricate. But of the complex of factors which have been at work since the middle of the Tertiary in giving to this flora its present distribution, we know far too little to permit the elaboration of a more comprehensive theory. Until we possess a much larger body of paleontological evidence, and a better understanding of past climatic conditions, we must be content with some such working hypothesis.

When we come to inquire into the conditions of climate and of soil which permit the actual existence of numerous Lower Austral forms in juxtaposition to a Transition and even Canadian flora, we enter upon an investigation that is within the domain of exact research. Here we are dealing with things tangible, which can to some extent be weighed and measured.

First let us compare the climate of the Appalachian Region in the Southern States with that which prevails under the same latitude in the Austro-riparian area, directing our attention to the factors of temperature which have the largest effect in determining the zonal distribution of organisms. These are believed to be: (1) the normal number of days during the year which possess a temperature above 6° C. (43° F.); (2) the normal sum total of temperatures above 6° C. during the period thus defined;* and (3) the normal mean of the six consecutive hottest weeks.† In the following table data are given for four stations in the mountain region and for two of

* The factor which is believed to fix the northern and upper limit of the great life zones. See Merriam in *Nat. Geogr. Mag.*, 6 : 229–238, 1894. Also Life Zones and Crop Zones, Bull. Div. Biol. Survey, U. S. Dept. Agric., 10 : 54, 1898.

† The factor taken as determining the southern and lower limit of the zones, Merriam, l. c.

the most northern in the Austro-riparian area.

The Highlands station is cited here for the sake of comparison, but does not otherwise answer our purpose, its elevation being so great as to preclude the occurrence of any important number of Lower Austral species. Knoxville falls slightly below the minimum altitude to which this discussion was limited at the outset; but owing to its proximity to some of the most interesting colonies described above, and in the absence of the requisite data from points lying nearer them, it has seemed best to give it place in the table. The most useful data are those given for Asheville and for Valley Head. Both have an altitude of more than 300 meters (1,000 feet) above the sea, and at both points a considerable number of Austro-riparian forms is known to occur.

STATION.	Altitude.	Days with temperature above 6°C. (43°F.).	Sum total above 6°C. (43°F.).	Normal Mean of 6 hottest weeks.
Highlands, N. C.	3817 ft.	234	1970.5°C. (3547°F).	18.9°C. (66.1°F).
Asheville, N. C.	1981–2250 ft.	249	2604.5°C. (4688°F).	21.8°C. (71.3°F).
Knoxville, Tenn.	891–933 ft.	267	3090.5°C. (5563°F).	24.5°C. (76.1°F).
Valley Head, Ala.	1027 ft.	293	3049.0°C. (5488°F).	24.0°C. (75.2°F).
Norfolk, Va.	11–12 ft.	295	3359.5°C. (6047°F).	26.3°C. (79.3°F).
Memphis, Tenn.	117–273 ft.	307	3752.2°C. (6754°F).	27.2°C. (81°F).

At Asheville the normal sum total of effective heat is only about 80 per cent. of that at Norfolk, and slightly more than 66 per cent. of that at Memphis. The normal number of days of the year possessing physiologically effective temperatures is, at Asheville, about 85 per cent. of that at Norfolk, and about 82 per cent. of that at Memphis. At Valley Head, which is only about one-half as high as Asheville, and is considerably farther south, the normal sum total of heat stands to that of Norfolk in about the ratio of 11 to 12; and, to that at Memphis nearly as 4 to 5. The normal number of days of the year whose temperature exceeds 6° C. is only two less than at Norfolk. In short, Norfolk temperatures are farther below those of Memphis, than Valley Head temperatures are below those of Norfolk. The occurrence of many Austro-riparian species at Valley Head is therefore small matter for wonder. But in order to explain their presence at Asheville, and at other points along the French Broad River at elevations of 330 to 600 meters (1,100 to 2,000 feet),* where we find the temperature conditions as ordinarily expressed so different from those of the Austro-riparian area proper, other elements of the *milieu* must be brought into consideration. The two factors which are probably most effective in permitting those species to maintain themselves in what would seem to be an unfriendly environment are: (1) The amount of insolation; and (2) The nature of the soil.

1. *Insolation.* — A favorite situation in the mountains for colonies of Lower Austral species is on the southern exposure of hills, where the angle of inclination and the position with reference to the sun insure the greatest possible amount of insolation. The duration and intensity of the heat and light which such exposures receive from the sun on summer days must go far towards counterbalancing the effect of altitude in lowering the temperature during the hours of darkness, and in shortening the growing season. The flora of the Coastal Plain

*At Biltmore, N. C., with an altitude of 1,993 to 2,150 feet, occur *Arundinaria macrosperma*, *A. tecta*, *Hypericum virgatum*, *Helenium nudiflorum* and several other characteristic Lower Austral species.

under the same latitudes, while favored by the low elevation of the country, is less advantageously situated in that it does not usually receive the greatest possible force of the sun's rays during the hottest weeks of summer.

2. *Soil.* — The soil preferred by the great majority of Austro-riparian plants which are met with in the mountains, especially those of our first category, which are assumed to be of neo-tropical origin, is light, sandy and poor in organic matter ; consequently readily permeable to water and becoming quickly and strongly heated. It is very similar to the soils which cover a great part of the Coastal Plain. In a substratum of this character, whether on the lower slopes or in the river bottoms, we invariably find established the larger colonies of Lower Austral species. In consonance with their environment, most of them are xerophytic or hemi-xerophytic in structure, as is the case with a great portion of the vegetation of the coastwise pine-barrens.

On the heavier and consequently colder and wetter soils, and on slope exposures other than southern, the flora is always of predominately Transition character, at the same elevation or even, in places, descending to lower altitudes than are often reached on the opposite slope by Carolinian and Austro-riparian forms.

Unfortunately no investigations have yet been made in this mountain region which afford us exact data as to the amount of isolation received by plants growing in the situations described; nor have we the measurements of soil temperature which are necessary to the further prosecution of the present inquiry. A comparative study of this question in various parts of the Appalachian region and of the Coastal Plain, coupled with an investigation of the ecology of the vegetation along anatomical-physiological lines, would beyond all doubt yield results of the greatest interest and value. It is earnestly hoped that such an investigation can be undertaken in the nea future.

Thos. H. Kearney, Jr.

SCIENTIFIC BOOKS.

Gauss and the non-Euclidean Geometry. Carl Friedrich Gauss Werke. Band VIII. Göttingen. 1900. 4to. Pp. 458.

We are so accustomed to the German professor who does, we hardly expect the German professor who does not.

Such, however, was Schering of Göttingen, who so long held possession of the papers left by Gauss.

Schering had planned and promised to publish a supplementary volume, but never did, and only left behind him at his death certain preparatory attempts thereto, consisting chiefly of excerpts copied from the mauuscripts and letters left by Gauss. Meantime these papers for all these years were kept secret and even the learned denied all access to them.

Schering dead, his work has been quickly and ably done, and here we have a stately quarto of matter supplemental to the first three volumes, and to the fourth volume with exception of the geodetic part.

Of chief interest for us is the geometric portion, pp. 159–452, edited by just the right man, Professor Staeckel of Kiel.

One of the very greatest discoveries in mathematics since ever the world began is, beyond peradventure, the non-Euclidean geometry.

By whom was this given to the world in print?

By a Hungarian, John Bolyai, who made the discovery in 1823, and by a Russian, Lobachévski, who had made the discovery by 1826.

Were either of these men prompted, helped, or incited by Gauss, or by any suggestion emanating from Gauss?

No, quite the contrary.

Our warrant for saying this with final and overwhelming authority is this very eighth volume of Gauss's works, just now at last put in evidence, published to the world.

The geometric part opens, p. 159, with

Gauss's letter of 1779 to Bolyai Farkas the father of John (Bolyai János), which I gave years ago in my Bolyai as demonstrative evidence that in 1799 Gauss was still trying to prove Euclid's the only non-contradictory system of geometry, and also the system of objective space.

The first is false; the second can never be proven.

But both these friends kept right on working away at this impossibility, and the more hotheaded of the two, Farkas, finally thought he had succeeded with it, and in 1804 sent to Gauss his 'Göttingen Theory of Parallels.' Gauss's judgment on this is the next thing given (pp. 160–162). He shows the weak spot. "Could you *prove*, that $dkc=ckf=fkg$, etc., then were the thing perfect. However, this theorem is indeed true, only difficult, without already presupposing the theory of parallels, to prove rigorously." Thus in 1804 instead of having or giving any light, Gauss throws his friend into despair by intimating that the link missing in his labored attempt is true enough, but difficult to prove without petitio principii.

Of course we now know it is *impossible* to prove.

Anything is impossible to prove which is the equivalent of the parallel postulate.

Yet both the friends continue their strivings after this impossibility.

In this very letter Gauss says: "I have indeed yet ever the hope that those rocks sometime, and indeed before my end, will allow a through passage."

Farkas on December 27, 1808, writes to Gauss: "Oft thought I, gladly would I, as Jacob for Rachel serve, in order to know the parallels founded even if by another.

"Now just as I thought it out on Christmas night, while the Catholics were celebrating the birth of the Saviour in the neighboring church, yesterday wrote it down, I send it to you enclosed herewith.

"To-morrow must I journey out to my land, have no time to revise, neglect I it now, may be a year is lost, or indeed find I the fault, and send it not, as has already happened with hundreds, which I as I found them took for genuine. Yet it did not come to writing those down, probably because they were too long, too difficult, too artificial, but the present I wrote off at once. As soon as you can, write me your real judgment."

This letter Gauss never answered, and never wrote again until 1832, a quarter of a century later, when the non-Euclidean geometry had been published by both Lobachévski and Bolyai János.

This settles now forever all question of Gauss having been of the slightest or remotest help or aid to young János, who in 1823 announced to his father Farkas in a letter still extant, which I saw at the Reformed College in Maros-Vásárhely, where Farkas was professor of mathematics, his discovery of the non-Euclidean geometry as something undreamed of in the world before.

This immortal letter, a charming and glorious outpouring of pure young genius, speaks as follows:

"Temesvár 3 Nov., 1823.

"My dear and good father,

"I have so much to write of my new creations, that it is at the moment impossible for me to enter into great detail, so I write you only on a quarter of a sheet. I await your answer to my letter of two sheets; and perhaps I would not have written you before receiving it, if I had not wished to address to you the letter I am writing to the Baroness, which letter I pray you to send her.

"First of all I reply to you in regard to the binominal.

* * * * * *

"Now to something else, so far as space permits. I intend to write, as soon as I have put it into order, and when possible to publish, a work on parallels. At this moment it is not yet finished, but the way which I have hit upon promises me with certainty the attainment of the goal, if it in general is attainable. It is not yet attained, but I have discovered such magnificent things that I am myself astonished at them.

"It would be damage eternal if they were lost. When you see them, my father, you yourself will acknowledge it. Now I cannot say more of them, only so much: *that from nothing I have created another wholly new world.*

All that I have hitherto sent you compares to this only as a house of cards to a castle.

"P. S. I dare to judge absolutely and with conviction of these works of my spirit before you, my father; I do not fear from you any false interpretation (that certainly I would not merit), which signifies that, in certain regards, I consider you as a second self."

In his autobiography János says: "First in the year 1823 did I completely penetrate through the problem according to its essential nature, though also afterward further completions came thereto. I communicated in the year 1825 to my former teacher, Herrn Johann Walter von Eckwehr (later imperial-royal general), a written paper, which is still in his hands. On the prompting of my father I translated my paper into Latin, in which it appeared as *Appendix* to the *Tentamen* in 1832."

So much for Bolyai.

The equally complete freedom of Lobachévski from the slightest idea that Gauss had ever meditated anything different from the rest of the world on the matter of parallels I showed in Science, Vol. IX., No. 232, pp. 813–817.

Passing on to the next section, pp. 163–164, in the new volume of Gauss, we find it important as showing that in 1805 Gauss was still a baby on this subject. It is an erroneous pseudo-proof of the impossibility of what in 1733 Saccheri had called 'hypothesis anguli obtusi.' To be sure Saccheri himself thought he had proved this hypothesis inadmissible, so that Gauss blundered in good company; but his pupil Riemann in 1854 showed that this hypothesis gives a beautiful non-Euclidean geometry, a new universal space, now justly called the space of Riemann.

Passing on, we find that in 1808, Schumacher writes: "Gauss has led back the theory of parallels to this, that if the accepted theory were not true, there must be a constant *à priori* line given in length, which is absurd. Yet he himself considers this work still not conclusive."

Again, with the date April 27, 1813, we read: "In the theory of parallels we are even now not farther than Euclid was. This is the partie honteuse (shameful part) of mathematics, which soon or late must receive a wholly different form."

Thus in 1813 there is still no light.

In April, 1816, Wachter, on a visit to Göttingen, had a conversation with Gauss whose subject was what he calls the anti-Euclidean geometry. On December 12, 1816, he writes to Gauss a letter which shows that this anti-Euclidean geometry, as he understands it, was far from being the non-Euclidean geometry of Lobachévski and Bolyai János.

The letter as here given by Staeckel, pp. 175–176, is as follows:

* * * "Consequently the anti-Euclidean or your geometry would be true. However, the *constant* in it remains undetermined: why? may perhaps be made comprehensible by the following:

"* * * The result of the foregoing may consequently be so expressed:

"The Euclidean geometry is false; but nevertheless the true geometry must begin with the same eleventh Euclidean axiom or with the assumption of lines and surfaces which have the property presumed in that axiom.

"Only instead of the straight line and plane are to be put the great circle of that sphere described with infinite radius together with its surface.

"From this comes indeed the one inconvenience, that the parts of this surface are merely symmetric, not, as with the plane, congruent; or that the radius out on the one side is infinite, on the other imaginary. Only it is clear how that inconvenience is again overbalanced by many other advantages which the construction on a spherical surface offers; *so that probably also then even*, if the Euclidean geometry were true, the necessity no longer indeed exists to consider the plane as an infinite spherical surface, though still the fruitfulness of this view might recommend it.

"Only, as I thought through all this, as I had already fully satisfied myself about the result, in part since I believed I had recognized the ground (la métaphysique) of that indeterminateness necessarily inherent in geometry—also even the complete indecision in this matter, then, if that proof against the Euclidean geometry, as I could not expect, were not to be considered as stringent; in part, so not to consider as lost all the many previous researches in plane geometry, but to be used with a few modifications, and that still also the theorems of solid geometry and mechanics might have approximate validity, at least to a quite wide limit, which perhaps yet could be more nearly determined; I found this evening, just while busied with an attempt to find an entrance to your transcendental trigonometry, and while I could not find in the plane sufficing determinate functions thereto, going on to space constructions, to my no small delight the following *demonstration for the Euclidean parallel theory.* * * *

"* * * Just in the idea to conclude I remark still, that the above proof for the Euclidean parallel-theory is fallacious. * * * Consequently has here also the hope vanished, to come to a fully decided result, and I must content myself again with the above cited. Withal I believe I have made upon that way at least a step toward your transcendental trigonometry, since I, with aid of the spherical trigonometry, can give the ratios of all constants, at least *by construction of the right-angled triangle.* I yet lack the actual reckoning of the base of an isosceles triangle from the side, to which I will seek to go from the equilateral triangle."

As to Gauss's transcendental trigonometry, nothing was ever given about it but its name. *Requiescat in pace.*

Yet Gauss writes, April 28, 1817:

"Wachter has printed a little piece on the foundations of geometry.

"Though Wachter has penetrated farther into the essence of the matter than his predecessors, yet is his proof not more valid than all others."

We come now to an immortal epoch, that of the discovery of the real non-Euclidean geometry by Schweikart, and his publication of it under the name of Astral-Geometry.

On the 25th of January, 1819, Gerling writes to Gauss:

"Apropos of parallel-theory I must tell you something, and execute a commission. I learned last year that my colleague Schweikart (prof. juris, now Prorector) formerly occupied himself much with mathematics and particularly also had written on parallels.

"So I asked him to lend me his book. While he promised me this, he said to me that now indeed he perceived how errors were present in his book (1808) (he had, for example, used quadrilaterals with equal angles as a primary idea), however that he had not ceased to occupy himself with the matter, and was now about convinced that without some datum the Euclidean postulate could not be proved, also that it was not improbable to him that our geometry is only a chapter of a more general geometry.

"Then I told him how you some years ago had openly said that since Euclid's time we had not in this really progressed; yes, that you had often told me how you through manifold occupation with this matter had not attained to the proof of the absurdity of such a supposition. Then when he sent me the book asked for, the enclosed paper accompanied it, and shortly after (end of December) he asked me orally, when convenient, to enclose to you this paper of his, and to ask you in his name to let him know, when convenient, your judgment on these ideas of his.

"The book itself has, apart from all else, the advantage that it contains a copious bibliography of the subject; which he also, as he tells me, has not ceased still further to add to."

Now comes, pp. 180–181, the precious enclosure, dated Marburg, December, 1818, which, though so brief, may fairly be considered the first *published* (not printed) treatise on non-Euclidean geometry.

It is a pleasure to give this here in English for the first time.

The non-Euclidean Geometry of 1818: By SCHWEIKART.

"There is a two-fold geometry—a geometry in the narrower sense—the Euclidean, and an astral science of magnitude."

The triangles of the latter have the peculiarity, that the sum of the three angles is not equal to two right angles.

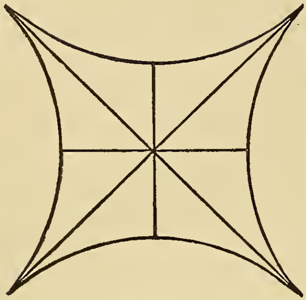
This presumed, it can be most rigorously proven:

(*a*) That the sum of the three angles in the triangle is *less* than two right angles;

(*b*) That this sum becomes ever smaller, the more content the triangle encloses;

(*c*) That the altitude of an isosceles right-angled triangle indeed ever increases, the more one lengthens the side; that it, however, cannot surpass a certain line, which I call the *constant.*

Squares have consequently the following form :



Is this constant *for us* half the earth's axis (as a consequence of which each line drawn in the universe from one fixed star to another, which are ninety degrees apart from one another, would be a tangent of the earth-sphere), so is it in relation to the spaces occurring in daily life infinitely great.

The Euclidean geometry holds good only under the presupposition that the constant is infinitely great. Only then is it true that the three angles of every triangle are equal to two right angles ; also this can be easily proved if one takes as given the proposition that the constant is infinitely great.

Such is the brief declaration of independence of this hero.

Nor were Schweikart's courage and independence without farther issue. Under his direct influence his own nephew, Taurinus, developed the real non-Euclidean trigonometry and published it in 1825, with successful applications to a number of problems.

Moreover, this teaching of Schweikart's made converts in high places.

In the letter of Bessel to Gauss of 10 Feb., 1829 (p. 201), he says : "Through that which Lambert said, and what Schweikart disclosed orally, it has become clear to me that our geometry is incomplete, and should receive a correction, which is hypothetical and, if the sum of the angles of the plane triangle is equal to a hundred and eighty degrees, vanishes.

"That were the *true* geometry, the Euclidean the *practical*, at least for figures on the earth."

The complete originality and independence of Schweikart and of Lobachévski are recognized as a matter of course in the correspondence between Gauss and Gerling, who writes, p. 238 : "The Russian steppes seem, therefore, indeed a proper soil for these speculations, for Schweikart (now in Königsberg) invented his 'Astral-Geometry' while he was in Charkow."

This fixes the date of the first conscious creation and naming of the non-Euclidean geometry as between 1812 and 1816.

Gauss adopts and uses for himself this first name, Astral-Geometry (1832, p. 226 ; 1841, p. 232).

At length the true prince comes. On February 14, 1832, Gauss receives the profound treatise of the young Bolyai János, the most marvellous two dozen pages in the history of thought. Under the first impression Gauss writes privately to his pupil and friend Gerling of the ideas and results as 'mit grosser Eleganz entwickelt.' He even says 'I hold this young geometer von Bolyai to be a genius of the first magnitude.'

Now was Gauss's chance to connect himself honorably with the non-Euclidean geometry, already independently discovered by Schweikart, by Lobachévski, by Bolyai János.

Of two utterly worthless theories of parallels Gauss had already given extended notices in in the *Göttingische gelehrte Anzeigen* (this volume, pp. 170–174 and 183–185).

To this marvel of János, Gauss vouchsafed never one printed word.

As Staeckel gently remarks, this certainly contributed thereto, that the worth of this mathematical gem was first recognized when John had long since finished his earthly career.

The 15th of December, 1902, will be the centenary of the birth of Bolyai János.

Should not the learned world endeavor to arouse the Magyars to honor Hungary by honoring then this truest genius her son?

GEORGE BRUCE HALSTED.
AUSTIN, TEXAS.

SCIENTIFIC JOURNALS AND ARTICLES.

IN the July number of the *American Journal of Insanity*, Dr. J. G. Rogers, of Indiana, presents an article entitled 'A Century of Hospital Building for the Insane,' which is worthy of much attention. He favors the erection of buildings which will permit classification into separated groups, not less than sixteen and twenty are preferable. The common dining-hall and the common kitchen are commended on the score of economy. Details follow in regard to methods and materials of construction, lighting, ventilation, etc.

Special provision should be made for certain classes of the insane, such as farm colonies for a working class, separate buildings for tubercular patients and infirmary buildings for the harmless and helpless.

Dr. C. A. Good, of Michigan, gives a 'Review of Chronic Progressive Chorea (Huntington's), with Report of a Case.' In the case reported excellent lithographs are given of microscopic sections which demonstrate degenerative changes in the muscles; pigment granules within the cells of the posterior root ganglion; and cysts and cell degeneration in the cerebral cortex.

Dr. H. J. Berkley, of Baltimore, reports a fatal case of dementia paralytica from a multiple thrombosis of bacterial origin. The theory is advanced that the thrombosis of the cerebral vessels was due to changes in the blood induced by toxic products, as well as from the presence of bacteria in such numbers as to form a nidus for a blood coagulation.

Dr. C. W. Pilgrim, of Poughkeepsie, in a paper entitled 'The Study of a Year's Statistics' gives interesting conclusions respecting patients under treatment at the Hudson River State Hospital. Of the patients admitted during the year, 41.5 per cent. presented symptoms of melancholia; 32.5 per cent. presented symptoms of mania; 20 per cent. were cases of dementia and 6 per cent. had dementia paralytica. Among those admitted 30 per cent. recovered during the year or had prospects of recovery; 12 per cent. were improved; 11 per cent. died and 47 per cent. were chronic cases when they came to the hospital and probably will die uncured. Some interesting statistics are given concerning the months during which deaths were most frequent: 61 per cent. of deaths occurred between October and April and 39 per cent. only between April and October. The 'hour of death' showed that 26 per cent. died between midnight and 6 A. M.; 19 per cent. between 6 A. M. and noon; 31 per cent. between noon and 6 P. M., and 24 per cent. between 6 P. M. and midnight.

Dr. A. H. Harrington, of Danvers, Massachusetts, believes that 15 per cent. of all deaths in hospitals for the insane in the United States are due to tuberculosis, and declares it to be "the duty of the State to provide its hospitals with the means of taking care of its tuberculous insane in such a manner as shall prevent the infection of the non-tubercular, and also give the necessary care to those suffering from the disease."

Dr. C. P. Bancroft, of Concord, New Hampshire, discusses the trial and conviction of Bradford P. Knight, of Augusta, Maine, who committed an atrocious murder while evidently insane, and who, although declared guilty of murder in the first degree, was prior to sentence transferred to a hospital for the insane. The jury returned the only possible verdict under the explicit charge of the presiding judge, which was based upon the erroneous idea that legal insanity differs in some mysterious manner from medical insanity; in other words, that the presence of insanity does not necessarily preclude responsibility for actions.

Dr. P. M. Wise, of New York, traces the steps which have been taken in the creation and development of the Pathological Institute of the New York State hospitals, and mentions the difficulties which have been encountered in the prosecution of the work.

'Suicide and its Increase' is the title of a paper by G. Styles, of Michigan, which presents the following suggestive statistics:

Forty years ago it was shown that while only 4 in every 10,000 persons rated as paupers died by their own hands, nearly 7 coachmen or other servants, 5 bankers or professional men, 7.8 dragoons, 7.43 tailors, shoemakers and bakers, while the trades making the best showing (1.33) were carpenters, butchers and masons. Of the countries concerned, Sweden has the lowest average, only 1 to 92,000; Russia, 1 to 35,000; the United States, 1 to 15,000; Saxony, 1 to 8,446; while in the cities of St. Petersburg and London, England, the proportion was 1 to 21,000. Taking the last fifty years, we find that for every 100,000 inhabitants of France there were, from 1841–45, 9 suicides; from 1846–50, 10; from 1861–70, 13; from 1871–75, 15; from 1876–80, 17; for 1889, 21; for 1893, 22; for 1894, 26. Durkheim shows that from 1826 to 1890 the number of suicides in Belgium increased 72 per cent.; in Prussia, 411 per cent.; in Austria, 238 per cent.; in France, 318 per cent.; in Saxony, 212 per cent., while in Sweden and Denmark the increase has been the lowest, viz., 72 and 35, respectively. That religion seems to wield an important influence in connection with self-murder is evident from the fact that in Roman Catholic communities suicide is less prevalent."

THE *Journal of Physical Chemistry*, November, 'On the Solubility of Manganous Sulphate,' by F. G. Cottrell. A determination of the solubility of the hydrates containing 1, 4, 5 and 7 molecules of water of crystallization—no other hydrates were found. The salt of commerce is sometimes that with four, sometimes that with five molecules of water. 'Catalysis and Chemical Energy,' by Oscar Loew. In catalysis "it is the oscillations of the free heat energy of the atmosphere which are modified by certain peculiarities of the platinum atom in such a manner that they can pass still more easily than they usually do into the oscillations of chemical energy. The catalytic action of certain organic compounds is due to the chemical energy of labile atoms." 'The Reaction between Chloroform and Potassium Hydroxide,' by A. P. Saunders. In all probability the action proceeds in stages, in each of which only two molecules react together. 'Vapor-Pressure Relations in Mixtures of Two Liquids, III,' by A. Ernest Taylor. Attention may well be called to the fact that to almost every article contained in this *Journal* since its inception is appended a brief summary of the results obtained and conclusions drawn. It would be a great advantage if this practice prevailed in all our scientific journals.

THE Medical Society of New York University has planned the establishment of a quarterly journal to be called *The New York University Bulletin of the Medical Sciences* and to be edited by a committee of the Society under the business management to be designated by the University. The contents of the Bulletin are to be: (1) Original articles directly contributed to the bulletin. (2) Abstracts or *extenso* reproductions of articles originally published elsewhere. (3) Short communications made at the meetings of the Medical Society. (4) Brief minutes of those meetings. (5) Reports on methods devised or tested in the departments of the medical college. (6) A reference list of publications by those connected with the medical college.

SOCIETIES AND ACADEMIES.

NATIONAL ACADEMY OF SCIENCES.

At the winter meeting of the National Academy of Sciences, held at Brown University, Providence, R. I., on November 13, 14 and 16, the following program was presented:

I. 'Investigations of Light and Electricity with the Aid of a Battery of Twenty Thousand Cells,' by J. Trowbridge.

II. 'Progressive Evolution of Characters in the Young Stages of Cephalopods,' by Alpheus Hyatt.

III. 'Descriptive Method of Presenting the Phenomena of the Cycle of Evolution among Cephalopods,' by Alpheus Hyatt.

IV. 'The Porous Cup Voltameter,' by T. W. Richards.

V. 'An Account of the Study of Growing Crystals by Instantaneous Microphotography,' by T. W. Richards.

VI. 'Stereographic Projection and Some of its Possibilities from a Graphical Standpoint,' by S. L. Penfield.

VII. 'On the Development of the Pig,' by C. S. Minot.

VIII. 'Normal Plates illustrating the Development of the Rabbit and the Dogfish,' by C. S. Minot.

IX. 'Note on the Energy of Recent Earthquakes,' by T. C. Mendenhall.

X. 'Spectrum of Sodium in a Magnetic Field,' by A. A. Michelson.

XI. 'A Report of the Spectrum Work carried on with the Aid of a Grant from the Bache Fund,' by H. A. Rowland.

XII. 'On the Explanation of Inertia and Gravitation by Means of Electrical Phenomena,' by H. A. Rowland.

XIII. 'Distribution and Phylogeny of Limulus,' by A. S. Packard.

XIV. 'Male Preponderance (Androrhopy) in Lepidopterous Insects,' by A. S. Packard.

XV. 'The Synthesis and Reactions of Sodium Acetate Ester, and their Relation to a New Interpretation of Chemical Metathesis,' by A. Michael.

XVI. 'On the Genesis of Matter,' by A. Michael.

XVII. 'Demonstration of the Projection of One Grating by Another,' by C. Barus.

XVIII. 'Exhibition of Certain Novel Apparatus; A Wave Machine; An Expansion Lens; A Recording System of Two Degrees of Freedom; A Tube Showing Colored Cloudy Condensation,' by C. Barus.

XIX. 'On Stability of Vibration and on Vanishing Resonance,' by C. Barus.

XX. 'Hysteresis-like Phenomena in Torsional Magnetostriction and their Relation to Viscosity,' by C. Barus.

XXI. 'Progress in the Echelon Spectroscope,' by A. A. Michelson.

XXII. 'Report on the Meeting of the International Association of Academies held at Paris, July 31, 1900,' by J. M. Crafts.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

THE regular meeting of the New York Section of the American Chemical Society was held October 5th at the Chemists' Club.

The following papers were read: 'Dr. Meyer's Tangent System of Sulphuric Acid Manufacture,' by C. Glazer; 'Note on the Determination of Zinc in the Franklin, New Jersey, Ores by the Ferrocyanide Method,' by Wm. H. Bassett.

The chair appointed C. Richardson, P. de P. Ricketts and M. Loeb a committee on prizes.

M. T. BOGERT,
Sec'y pro tem.

AT the meeting on November 9th, Dr. C. A. Doremus presided and over fifty members were present. 'A Brief Review of Antipyrine and its more Important Derivatives,' was the subject of a paper by D. C. Eccles. Referring to the matter of papers to be read before the Section during the season, Dr. McMurtrie said that every chemist actively engaged in any subject could bring topics before the Section, which would be of great interest to others, and of no less interest because of not being in shape for publication in the journal. And, further, he urged the members to realize that interesting meetings required that each should furnish his share of the work.

The chairman, Dr. Doremus, said he thought the opportunity of bringing their work before the Society was not appreciated by the younger members, who had better seek the opportunity in their own interest than wait for invitation.

Special announcement was made of the death of Dr. E. R. Squibb, so long an enthusiastic member and active co-worker in the Society. Personal reminiscences were given by Dr. Rice and by Messrs. Bogert, McMurtrie, Breneman, Eccles and Doremus.

It was moved and seconded that a committee be appointed to draw up suitable resolutions expressing the Society's appreciation of Dr. Squibb's character, of his services to chemical science, and of the loss sustained by the Society in his death. And, further, that the resolutions should be engrossed in duplicate—a copy to be sent to his family and one to be preserved by the Society.

DURAND WOODMAN,
Secretary.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A MEETING of the Section was held on November 5th, at 12 West 31st Street, New York.

A paper was read by Dr. F. L. Tufts, of Columbia University, on 'The Flow of Air through Granular Materials at Different Pressures.' These experiments were made in connection with others on the transmission of sound through the same materials. Three different materials were experimented on, composed of lead shot of three sizes, the diameters of the shot being respectively 4.37 mm., 2.79 mm., and 1.22 mm. The shot was placed in a tube and air was forced through at different pressures, the rate of flow of air being measured by a gas meter and the pressure differences by a water manometer. It was found that for a given size of shot and a given pressure gradient, the rate of flow was independent of the length of the column of shot through which the air flowed. The rate of flow, however, in the three cases experimented with, did not increase as rapidly as the pressure gradient. This was more noticeable with the coarse shot than with the finer. For pressure gradients of about 0.01 cm. of water pressure per centimeter of length of material, the rate of flow through the coarsest shot was ten times the rate through the finest, while for a pressure gradient fifty times as great the rate of flow was a little less than three times as great in the coarsest as in the finest. With each size of shot the space occupied by air was about 39 per cent. of the total space occupied by the shot.

Wm. S. Day,
Sec'y of Section.

DISCUSSION AND CORRESPONDENCE.

A DISCLAIMER.

The attention of the undersigned has been called to the fact that an organization known as 'The American College of Sciences,' situated in Philadelphia, is issuing circulars advertising a course of instruction in hypnotism as prepared in part by them. These circulars contain many statements about hypnotism and about the advantages to be derived from its study and practice which are not justified by the articles written by the undersigned, which in their judgment cannot be substantiated by any facts known to science, and which they believe to be in the highest degree misleading. Furthermore, the undersigned are of the opinion that the practice of hypnotism by the general public is attended by dangers which have no compensating advantages, and would in no case countenance any scheme which encourages its practice under such conditions. They feel it incumbent upon them, therefore, to make a public statement of the circumstances under which these articles were written.

Each of them was requested, individually, by 'The New York State Publishing Company,' of Rochester N. Y., to prepare an article for a collection of such articles. Inquiries made of this Company elicited no suggestion that the collection was to be issued by any other than the usual method of publication and sale, and the articles were contributed by the undersigned without their having any knowledge or suspicion that they would be used as constituent parts of a course of instruction in hypnotism. Had they known that they would be so used, they would have refused to contribute the articles in question. They now disclaim all responsibility for the methods adopted by the American College of Sciences and for all statements made in its publications, excepting only those found in the several articles above referred to, and for them their individual authors are alone responsible.

While the position of the undersigned on these questions is perhaps already sufficiently well known to the academic world, they feel that this disclaimer is due to the general public.

J. Mark Baldwin, Princeton University.
W. P. Carr, Columbian University.
E. W. Scripture, Yale University.
J. W. Slaughter, University of Michigan.
Alfred Reginald Allen, Philadelphia Polyclinic Hospital.
Gabriel Campbell, Dartmouth College.
Arthur MacDonald, U. S. Bureau of Education.
James H. Leuba, Bryn Mawr College.
Robert M. Yerkes, Harvard University.
Clark Wissler, Columbia University.
Ernest Carroll Moore, University of California.
Edward H. Eldridge, Temple College.
William Romaine Newbold, University of Pennsylvania.

CURRENT NOTES ON METEOROLOGY.

A RECENT STUDY OF ECLIPSE METEOROLOGY.

'A Discussion on the Observations recorded during the Solar Eclipse of January 22, 1898, at 154 Meteorological Stations in India' is the title of Vol. XI, Part II, of the Indian Meteorological Memoirs (Calcutta, 1900). This is a report by Mr. John Eliot, Meteorological Reporter to the Government of India, consisting of 66 pages of text and tables, together with 38 plates showing curves of temperature, pressure, cloudiness, humidity, etc., at different stations. In these plates the actual and probable curves of the diurnal variation of the different weather elements are given for a large number of stations, so that the effects produced by the eclipse can easily be seen. A brief summary of results gives in a very condensed form the most important points brought out in Mr. Eliot's study.

The total reduction of air temperature accompanying and due to the eclipse varied directly as the amount of the greatest obscuration of the sun, and also to a slight extent with local conditions and peculiarities of air movement. The *average* maximum reduction near the belt of totality in the interior of India was 8°. The maximum reduction of temperature appears to have occurred at Karwar (12°), and at Sahdol (10°). The time of the greatest diminution of temperature followed the time of greatest obscuration of the sun by an average interval of 23 minutes. The pressure observations indicate that there was a steady increase of pressure during the first stage of the eclipse, of little or no resulting variation during the second stage, and of increase after the termination of the eclipse at a smaller rate than during the first stage, and also at a decreasing rate. The air movement fell off very rapidly during the first stage (that of decreasing heat and light), and was feeble during the greater part of the second stage. One of the most noteworthy meteorological features of the eclipse was a short sudden gust which occurred about twenty minutes after the commencement of the eclipse at a majority of stations in and near the belt of totality. There was a large and rapid increase of the vapor pressure and also of the relative humidity, followed by an equally large and rapid decrease, the whole constituting an oscillatory variation of large amplitude and very short period.

NATIONAL GEOGRAPHIC MAGAZINE.

THE *National Geographic Magazine* for November contains three articles of meteorological interest. The first is an account of 'The Manila Observatory,' by Father José Algué, S. J. This observatory has done excellent work, especially in connection with the typhoons of the Far East. Frequent reference has been made to the publications of the Manila Observatory in these Notes. The second paper is by Mr. F. H. Newell, of the U. S. Geological Survey, and deals with *The Limited Water Supply of the Arid Region.* The land west of the 100th meridian was, as Mr. Newell points out, at first thought to be worthless for agricultural purposes. Then the pendulum swung far in the other direction, and the general feeling was that there was abundant water for irrigation and that all the land could be utilized. Finally we have reached the present stage, when the limits of the water supply are coming to be fairly well seen, 'and the statement that only five or ten per cent. of the land can be reclaimed excites comparatively little interest.' The third paper of meteorological importance is one by Gen. A. W. Greely, entitled 'Hurricanes on the Coast of Texas,' in which an account is given of the hurricane of September 15–16, 1875, 'which caused a relatively greater loss of life and property to the town of Indianola, Texas, than was inflicted on Galveston by the recent hurricane.'

THE CAPE HORN PASSAGE.

THE November *Pilot Chart of the North Pacific Ocean* presents a brief but interesting discussion of the passage for sailing vessels around Cape Horn to the westward. This discussion is based on the reports received from 22 vessels which rounded Cape Horn from east to west during 1899, and brings out in a very striking manner the direct control exercised over the sailing routes around Cape Horn by even the temporary winds of a cyclonic depression. It appears that the most favorable weather condition for the passage is the presence, during the period necessary for rounding Cape Horn and for crossing latitude 50°S. in the Pacific, of a center of low pressure in the immediate vicinity of the Cape, and not too far to the southward. This distribution of pressure gives N.E., E. and S.E. winds in succession in the case of a westbound vessel which keeps this center constantly on the starboard side, *i. e.*; which passes the center to the southward. One of the fastest passages made around Cape Horn in 1899, that of the British bark *Inveramsay*, was made under these conditions.

UNDERGROUND TEMPERATURES DURING A HOT WAVE IN SOUTH AUSTRALIA.

IN his report on the *Rainfall in South Australia and the Northern Territory during 1897*, Sir Charles Todd, Government astronomer of South Australia, calls attention to an interesting case of slow penetration into the ground of the high temperatures of a hot wave. During

February, 1897, there occurred a long spell of hot weather, lasting from the 7th to the 18th with maximum temperatures between 82.6° on the 7th and 107.3° on the 10th, or over 100° on five days and over 90° on ten consecutive days. On the morning of February 8th the temperature at the Adelaide Observatory at three feet below the surface was 71.5°; at five feet, 68.6°; and at eight feet, 67.5°. On the morning of the 18th the readings were 73.6°; 69.3° and 68.4° respectively, showing a gradual increase during the intervening period, the increase being 2.1° in the ten days at three feet, 0.7° at five feet and 0.9° at eight feet. These observations show clearly 'that it requires a very long continuance of heat to materially affect the thermometers ten feet only below the surface.'

R. DeC. Ward.

BOTANICAL NOTES.

THE POWDERY MILDEWS.

A notable contribution to the literature of fungology has appeared in Mr. Ernest S. Salmon's 'Monograph of the Erysiphaceæ,' published as Volume XI. of the Memoirs of the Torrey Botanical Club. It constitutes a thick octavo pamphlet of nearly three hundred pages, and nine plates of one hundred and seventy-five figures. The paper opens with a couple of pages of remarks on the limits of the family, eight or nine pages on morphology and life history, a few pages devoted to the history of the study of the group, the connection between host and parasite, and distribution of the species. The family is restricted to the six genera *Sphaerotheca*, *Podosphaera*, *Uncinula*, *Microsphaera*, *Erysiphe and Phyllactinia.* All the known species in the world are included, and it speaks well for the conservatism of the author that although he examined the material in the most important collections in Europe and America, he has found it necessary to describe but two new species and two new varieties. Such conservatism and self-denial are most commendable and encouraging, and may well serve as a model for other monographers, who too often find new species every time they turn over their material.

So conservative has been the writer of this monograph that under his treatment the grea number of specific names in the family is reduced to but sixty species and varieties. Thus, while *Erysiphe* has had one hundred and sixty-five species and varietal names associated with it, there are here but nine; so the fifty-eight names under *Microsphaera*, are reduced to nineteen; the twenty-four under *Podosphaera* to five; the twenty-one under *Sphaerotheca* to six; the thirty-eight under *Uncinula*, to tweuty; and the nine under *Phyllactinia*, to one. Of course it is not to be supposed that Mr. Salmon made all these reductions; to a large extent they had been made already by other students of the family, but it is greatly to his credit that with such an opportunity he did not give us a greatly increased list.

According to this monograph the accepted names of some of the more common of the Powdery Mildews are as follows: Cherry Mildew, *Podosphaera oxycanthae;* Rose Mildew, *Sphaerotheca pannosa;* Gooseberry Mildew, *Sphaerotheca mors-uvæ;* Willow Mildew, *Uncinula salicis;* Grape Mildew, *Uncinula necator;* Lilac Mildew, *Microsphæra alni;* Pea Mildew, *Erysiphe polygoni;* Sunflower Mildew, *Erysiphe cichoracearum.*

PLANT BREEDING.

From a paper by H. J. Webber and E. A. Bessey on 'The Progress of Plant Breeding in the United States,' recently published in the Year-book of the Department of Agriculture, the scientific botanist may learn much which may well surprise him as to what has been accomplished in the work of plant breeding. That man can bring about definite results by the careful breeding of animals is more or less well known, but that plants may be bred with as definite an object in view, and as successfully, is not yet a matter of common knowledge.

It is only during the latter half of the present century that much progress has been made in plant breeding proper, the earlier efforts at the improvement of plants having been through the selection of seeds of the most desirable plants for further cultivation. Downing, Hovey, Wilder and some other far-seeing horticulturists of the earlier days continually urged the breeding ('crossing') of the better varieties of fruits in order to combine the qualities and characteristics of the kinds so treated. This advice eventually bore fruit, and to-day the florist plans to bring about a definite result by securing offspring from the union of two plants, whose form, color, odor or other qualities he may wish to intensify or modify. Among fruits the grape, raspberry and strawberry have been much modified by careful breeding. The tomato illustrates what may be done by the skillful breeder, as practically all the improvement which it has undergone is due to carefully planned hybridization, followed by as careful selection. In like manner the cereals, maize and wheat, have been improved in recent years by the crossing of selected varieties.

THE BUTTERCUP FAMILY.

UNDER the title 'A Taxonomic Study of North American Ranunculaceæ,' Dr. C. K. Davis, of the State Normal School, St. Cloud, Minn., publishes a privately printed pamphlet of one hundred and seventy-three octavo pages describing the genera and species of the North American Ranunculaceae, native and introduced. The studies (entirely taxonomic) on which the pamphlet is based were made in Cornell University, where the author had access to the admirable collection of cultivated plants known as 'Cornell Garden Herbarium,' as well as of materials and books in the National Herbarium, the Herbarium of the New York Botanical Garden, and the Gray Herbarium of Harvard University. The result is an arrangement of the family differing considerably from that of either Bentham and Hooker in their 'Genera Plantarum,' or of Prantl in Engler and Prantl's 'Natürlichen Pflanzenfamilien,' although much more like the latter than the former. Dr. Davis proposes to divide the family (which for some reason not given he calls an 'order') into five tribes, which he arranges in the following sequence: I. *Crossosomeae;* II. *Pæonieae;* III. *Helleboreae;* IV. *Clematideae;* V. *Anemoneae.* The genus *Crossosoma* of Nuttall, referred by Bentham and Hooker to the Dilleniaceae, and by Engler and Prantl made the type of a separate family, Crossosomataceæ, is here included in the Ranunculaceæ. The two species and one variety occur in Southern California, Arizona, and Northern Mexico. In the *Helleboreae* the name *Cammarum* of Hill (*Brit. Herb.*, 1756) is substituted for Salisbury's name, *Eranthis* (1807), in accordance with the suggestion made by Professor Greene in *Pittonia*, April, 1897.

The work is quite uneven, some portions (notably those first published in the 'Minnesota Botanical Studies') being much more scientifically treated than others which were first printed in horticultural magazines. The pages falling under the latter category are printed in different type, often in poor type, marring the appearance of the book, and giving it a 'patchwork' appearance. However, in spite of its unfortunate printing it is worthy of a place in the library of every working botanist.

RED CEDAR DISEASES.

DR. VON SCKRENK, of the Shaw School of Botany and Special Agent of the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, describes (in Bulletin 21, of the Division) two fungi which produce diseases of the wood of the Red Cedar (*Juniperus virginiana*), known respectively as 'white rot' and 'red rot.' The first ultimately causes long holes, lined with the brilliant white remains of the decayed tissues, to appear in the wood at intervals of a few inches. This disease is found to be due to a species of *Polyporus* (Fomes) related to, if not identical with, *P. fomentarius*, and for which the author proposes the name *P. juniperinus.* It occurs in Kentucky and Tennessee. The 'red rot' is said to be more common than the preceding, and is more widely distributed, occurring in Missouri, Arkansas, Kentucky, Tennessee, Virginia and New York. It produces large holes in the wood, but these are brown within, and are lined with the brown, cubically cracked remains of the decayed wood. This is found to be due to another species of *Polyporus*, viz., *P. carneus*, a small, woody, flesh-colored polypore, which grows in the holes at the bases of the fallen branches. A number of photographs, excellently reproduced, illustrate this valuable paper.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

SCIENTIFIC NOTES AND NEWS.

The degree of Doctor of Science, established last summer by Oxford University, will soon be conferred in ordinary course for the first time. Those to whom it is to be granted are Professors E. B. Poulton, W. F. R. Weldon, H. A. Miers, A. E. H. Love and H. Turner; Mr. W. Hatchett Jackson, Radcliffe Librarian and the re-writer of Rolleston's Forms of Animal Life; Mr. F. A. Bather, of the British Museum (Natural History), and H. W. L. Tanner, professor in the University of South Wales.

President Eliot, of Harvard University, having been detained at Cambridge during the summer, has now been given leave of absence and has sailed for Europe. During his absence the duties of president will be performed by Dr. Henry P. Walcott, a member of the Corporation and chairman of the Massachusetts State Board of Health. Dr. Walcott graduated from Harvard in 1858 and received the M.D. from Bowdoin in 1861.

Professor Benjamin O. Peirce, of Harvard University, has been given a year's leave of absence and has sailed for Europe.

We regret to learn that Professor John P. Marshal, emeritus Pearson professor of geology at Tufts College, is seriously ill.

Professor Louis Dyer, of Oxford, is at present in the United States, having been invited by Mrs. Phoebe Hearst to give a course of eight lectures at the University of California. His subject is 'Mycenæan Greek Art,' and the lectures will be delivered from the 1st to the 9th of November.

The Hughlings Jackson Lecture of the Neurological Society of London for 1900 was delivered by Dr. Eduard Hitzig, professor of psychiatry and nervous diseases at Halle, on November 29th. Professor Hitzig took as his subject, 'Hughlings-Jackson and the Cortical Motor Centers in the Light of Physiological Research.' This triennial lectureship was founded by the Neurological Society in honor of Dr. Hughlings-Jackson, its first President, who three years ago delivered the first lecture.

The annual course of Christmas lectures, specially adapted to young people, at the Royal Institution will be delivered by Sir Robert Ball, F.R.S., Lowndean professor of astronomy in the University of Cambridge, whose subject is 'Great Chapters in the Book of Nature.' The first lecture will take place on December 27th, and the remaining lectures will be delivered on December 29, 1900, and on January 1, 3, 5 and 8, 1901.

Professor Macalister, M.D., has been elected president, and Professor Woodhead, M.D., W. H. R. Rivers, M.D., and G. Elliot Smith, M.D., have been elected fellows, of the Philosophical Society of Cambridge University.

The sum of £200 has been granted from the Craven Fund of Oxford University to Mr. Grenfell and Mr. Hunt for expenses of a journey to Egypt in search of papyri.

Mr. A. J. Drexel Biddle, of Philadelphia, has been elected a fellow of the Royal Meteorological Society of Great Britain.

Dr. Edward D. Jones, of the School of Economics of the University of Wisconsin, received a grand prize at the Paris Exposition for an exhibit of charts and monographs dealing with the resources and industries of the United States.

The King of Denmark has forwarded to Lieutenant Amdrup for his recent exploration of the hitherto unknown east Greenland coasts the 'gold medal for brilliant service.'

We regret to record the death, at the age of 69 years, of Dr. Eugène Janssen, member of the Superior Council of Hygiene and of the Belgian Royal Academy of Medicine, well-known for his work in hygiene.

We have already described the plans for the erection of a building at Berlin for the German Chemical Society and as a center for chemical science. The first step was taken on the occasion of Professor A. W. Hofmann's seventieth birthday in 1888, and the work was continued after his death in 1892. The building called the Hofmannhaus was formally opened on October 20th.

A party from the United States Geodetic and Coast Survey has sailed for Manila to chart the Philippine Archipelago.

THE chemical library of the late Professor Bunsen is now offered for sale at Leipzig.

THE eleventh annual meeting of the American Morphological Society will be held at the Johns Hopkins University, Baltimore, Md., December 27 and 28, 1900, under the presidency of Professor T. H. Morgan. The first session will begin Thursday, December 27th, at 9:30 A. M. Other sessions will be held on Thursday afternoon and Friday morning. The titles of papers and lists of exhibits should be in the hands of the Secretary, Professsor J. S. Kingsley, Tufts College, Mass., not later than December 10th; any title received after December 23d will be admitted only by special vote of the executive committee. The suggestion has been made that the Society have an informal meeting on Wednesday evening which shall be of a social character and in some respects similar to the gatherings of the Physiological Society. If sufficient encouragement is received arrangements will be made for such a meeting of the Morphological Society.

THE first annual meeting of the Illinois State Electric Association will be held at the University of Illinois, November 27, 1900. The Association was organized at Springfield, Ill., on April 24, 1900, and represents in its membership the leading electric light and power industries of the State.

PARTICULARS concerning the Ludwick Institute courses of free lectures on the natural sciences and their applications at the Academy of Natural Sciences of Philadelphia for the season 1900–1901 have been announced. The program is as follows:

Course I. 'Geographical Distribution of Animals.' Dr. Henry A. Pilsbry.

Course II. 'Entomology.' Dr. Henry Skinner.

Course III. 'Physiology and Hygiene.' Dr. Seneca Egbert.

Course IV. 'The Bird Life of Philadelphia and Vicinity.' Witmer Stone.

Course V. 'Metamorphism, as exemplified in the rocks of the Philadelphia Region.' Dr. Amos P. Brown.

Course VI. 'Influence of the Environment on Animal Life.' Dr. Benjamin Sharp.

Course VII. 'Botany.' Stewardson Brown.

Course VIII. 'The Survival of the Fittest Animals.' Dr. Philip P. Calvert.

Each course consists of five lectures which are delivered on Monday and Thursday evenings at 8 o'clock. Free season tickets can be obtained at the Academy from any of the lecturers or from Mr. A. C. Ashmead, 11th and Walnut Sts., Philadelphia.

THE annual report of the Council of the Royal College of Surgeons of England has recently been issued. According to the account in the London *Times*, it contains for the first time a list of honorary fellows. The list includes the names of the Prince of Wales, Lord Salisbury and Lord Rosebury, and of 35 eminent surgeons from all parts of the world. There are 1,221 fellows of the College and 17,510 members, being considerably over half of the number of names contained in the Medical Register for 1900.

AT the fourteenth ordinary general meeting of the Egypt Exploration Fund on November 7th, Professsor Flinders Petrie spoke of the new knowledge of ancient Egyptian civilization which had resulted from the explorations supported by the Society. The treasurer reported that about thirteen thousand dollars was spent in 1899–1900.

AN international association for the furtherance of the exploration of Central Asia is being formed at St. Petersburg.

THE *Antarctic*, the ship used by the Danish Lieutenant Amdrup during his recent successful East Greenland exploration expedition, has been bought by Dr. Otto Nordenskjöld, for his proposed South Polar expedition. The *Antarctic* once before visited the South Polar regions and is the same ship that Professor Nathorst used in two Antarctic expeditions.

THE French War Department has appropriated $80,000 for secret experiments on wireless telegraphy with a view to perfecting its applications in war.

UNIVERSITY AND EDUCATIONAL NEWS.

THE hall of Natural History of Trinity College will be formally opened on the afternoon of Friday, December 7th. Addresses will be given in Alumni Hall by Professor H. F. Osborn, of Columbia University, on 'The Progress of Vertebrate Paleontology in the United States,' and by Professor W. H. Howell, dean of Johns Hopkins University Medical Department, on 'Biology as an Element in College Training.' Following the addresses a reception will be held from five to seven o'clock in the Hall of Natural History.

Dr. William E. Quine, dean of the College of Physicians and Surgeons in Chicago, has given $25,000 to the College to endow its library, and Dr. D. A. K. Steele, another member of the faculty, has given a like amount to endow the pathological laboratory.

The Vice-Chancellor of Cambridge University has published a list of donations to the Benefaction Fund, which brings the total up to more than £66,000. Some £1,600 have also been contributed for the special purpose of equipping an experimental farm for the department of agriculture.

The department of pedagogy of the University of Illinois, under the direction of Professor E. G. Dexter, is establishing a pedagogical library and museum. The exhibits, part of which are loaned, are divided as follows: (1) Photographs, plans and, as far as possible, specifications and descriptions of school buildings; (2) Old and current catalogues and courses of study of public school systems and educational institutions; (3) Material constructed or prepared by pupils, including models in wood, metal and clay; work in paper and pasteboard, work in color and drawing, written exercises, etc.; (4) General educational reports and special publications; (5) School text-books and literature of all kinds for all grades; (6) School furniture and appliances, including charts, globes, desks, etc.; (7) Apparatus of all makes and kinds for school laboratories; (8) Catalogues, photographs and descriptions of material of the above descriptions.

A new regulation has been made by the Harvard faculty of arts and sciences, to allow students to obtain both the Bachelor of Arts and Bachelor of Science degrees in five years. The regulation is as follows: "Students who wish to take the degree of Bachelor of Science in addition to the degree of Bachelor of Arts may register in the Lawrence Scientific School after their third year in Harvard College (or after the satisfactory completion of fourteen courses counting toward the degree of Bachelor of Arts). They may obtain the degree of Bachelor of Arts on the satisfactory completion of the required number of courses counting toward that degree, and the degree of Bachelor of Science after at least two years in the Scientific School, the last year to be devoted to work prescribed by the administrative board of the Scientific School."

Lord Barnard formally opened the new science building, costing over £4,000, attached to the North-Eastern County School, Barnard Castle, England, on November 6th. The Bishop of Durham and others were present. Lord Barnard, in the course of his speech, advocated the endowment of a University for the north of England similar to the Birmingham University.

President D. C. Gilman, of the Johns Hopkins University has privately intimated to the trustees his intention of resigning at the close of the present academic year, which will complete 25 years of service since the opening of the University in 1876.

Professor Curie has been appointed professor of physics at Paris.

Dr. Erskine-Murray has been appointed lecturer and demonstrator of physics and mathematics at the University College, Nottingham, England.

Mr. E. J. Russell, B.Sc., assistant lecturer and demonstrator at Owens College, Manchester, has been appointed lecturer in chemistry at the South-Eastern Agricultural College in place of Mr. H. H. Cousins, M.A., who has been appointed agricultural chemist to the Government of Jamaica.

We also note the following appointments in German Universities: Dr. Georg Thilenius, of Strasburg, associate professor of anatomy in the University at Breslau; Dr. Adolf Kneser, of Dorpat, professor of mathematics in the Berlin School of Mines; Dr. Immendorf, of Bremen, professor of agricultural chemistry in the University at Jena and, at the experiment station of the same University, Dr. Oscar Böttcher, of Mökern, professor of agricultural chemistry and director of the station.

SCIENCE

FRIDAY, DECEMBER 7, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE HISTORY OF THE NEOTROPICAL REGION.

IN No. 276 of SCIENCE, April, 1900, Dr. Henry F. Osborn published an article on the 'Geological and Faunal Relations of Europe and America during the Tertiary Period,' to which I may here refer, as it may be useful for science to discuss the different opinions to which our study has led us.

It is singular that Mr. Osborn has no knowledge at all of the numerous papers published by the writer on the history of the neotropical fauna, and consequently it is necessary to say at first some words on these papers, and the new discoveries and ideas published in them. Referring here only to those of my publications in which the geological and zoögeographical relations of South America were fully discussed, I name the following:

1. 'Die Geographische Verbreitung der Flussmuscheln.' *Das Ausland,* Stuttgart, 1890, Nos. 48–49; and translated 'The Geographical Distribution of the Freshwater Mussels.' The New Zealand *Journal of Science,* Vol. I., Dunedin, 1891, pp. 151-154.

2. 'Ueber die Beziehungen der chilenischen und suedbrasilianischen Suesswasser fauna.' *Verhandlungen des deutschen wissenschaftlichen Vereines zu Santiago,* Vol. II., 1891, p. 142–19.

3. 'Ueber die alten Beziehungen zwischen Neuseeland und Suedamerika.' *Ausland,* Stuttgart, 1891, No. 18. Translated, 'On

the Ancient Relations between New Zealand South America.' *Transactions* of the New Zealand Institute, Vol. XXIV., 1891, p. 431–445.

4. 'Die Palaeo-Geographie Suedamerikas.' *Ausland*, Stuttgart, 1893, Nos. 1–4.

5. 'Revision der von Spix in Brasilien gesammelten Najaden.' *Archiv. für Naturgeschichte*, 1890, p. 117–170, Taf. IX.

6. 'Najaden von S. Paulo und die geographische Verbreitung der Suesswasserfaunen von Suedamerika.' *Archiv. für Naturgeschichte*, 1893, pp. 45–140, Taf. III.–IV.

7. 'Das neotropische Florengebiet und seine Geschichte.' *Engler's Botanische Jahrbücher*, Vol. XVII., 1893, pp. 1–54.

8. 'Die Ameisen von Rio Grande do Sul.' *Berliner entomologische Zeitschrift*, Band 39, 1894, pp. 321–446.

9. 'Os molluscos dos terrenos terciarios da Patagonia.' *Revista do Museu Paulista*, Vol. II., 1898, pp. 217–382, Pl. III.–IX., with Conclusions in English, pp. 372–380.

The study of the fresh water fauna, and especially of the Unionidæ of South America, gave me as a practical result the separation of two sub-regions 'Archiplata' and 'Archamazonia.' The first contains Chili, Argentina, Uraguay and Southern Brazil, the second Central and Northern Brazil (Archibrazil) and Guyana, Venezuela, etc. (Archiguyana). Archiplata contains numerous genera of Mollusca, Crustacea, etc., that are common to Chili and the La Plata district, such as *Unio*, *Chilina*, *Parastacus*, *Aeglea*, etc., including many species and even their parasites (*Temnocephala*), which are identical on both sides of the Andes. This contrasts sharply with the Archamazonian fauna, as tropical genera extend to Rio Plata and Rio Negro which are completely wanting in Chili and Peru. In Ecuador, however, the Cordillere form no such zoogeographical division, due certainly to differences in the geological history of both parts of the Andes. For example the Decapod Crustacea in Chili and in the whole of Archiplata are the Parastacidæ and Aegleidæ, but the Potamoninæ are in Archamazonia. Dr. Ortmann has opposed to my explanations the hypothesis that biological differences may be the true reason, exterminating the Potamoninæ that invaded Archiplata, but favoring the Parastacidæ. The observations made by the writer on the biology of these Crustacea emphatically annul the objection. In Northern Argentine, Rio Grande do Sul and St. Catherina, both coexist in the same waters and while the Potamonidæ prefer rivers and brooks, living among aquatic plants, the *Parastacus* selects muddy territory where it can burrow.

That the explanation is a geographical one is proved also by the fact that the species of Unionidæ, Mutelidæ, Ampullariidæ, etc., which occur in the La Plata and in the Rio Paraguay, are almost all Amazonic species. Moreover the faunal relations of the Paraná River are totally different from those of the Paraguay River. In confirmation of these zoogeographical facts the geological ones indicate to us in the Entrerian-formation Unio of the Niæa group, Chilina, Strophocheilus, etc., that is to say, the pure Archiplata fauna. These facts point out that the invasion of the Archamazonian element into Archiplata is quite a recent one. The intrusion of the Archamazonian element is Pliocene or post-Tertiary, and the Andes formed a barrier insurmountable to fresh-water crabs and mussels as well as to fishes, chelonians and alligators.

It is evident that the two faunal elements of South America correspond to geographical districts which were separated by the ocean during the greater part of the Tertiary. The intermixture of the two elements, and especially the intrusion of Bolivian ants, land snails, etc., in Eastern Brazil is by no means finished, but is a fact which we observe to-day. It is highly probable that these conditions, which are decisive not only for the fresh-water fauna but also for the land gastropods, have determined also the history of the mammals, which may have reached Brazil only in the Pliocene.

Although these inferences concerning the different faunal elements of the neotropical fauna, based on the zoogeographical work of the writer, seem to be quite conclusive, the matter is more difficult and hypothetical if we turn to the ancient relations of Archiplata and Archamazonia to other regions of the globe.

The connection of Archiplata with a great antarctic continent during the Cretaceous and Eocene formation seems now to be generally accepted, but the historic data given on the matter by Osborn are very incomplete. The first to discuss the question was the eminent botanist, Sir William Hooker, but the work of Wallace, and especially his axiom of the permanence of the great oceanic depths, for a long time retarded further progress. Not until 1883 did Hutton, with reference to New Zealand, and in 1890 the writer, with reference to Archiplata, turn aside to publish new facts in favor of the hypothesis of Hooker, which was also confirmed by Fl. Ameghino.

In relation to the ancient connection of Africa and Archamazonia I have given arguments (1890) in favor of a Mesozoic 'archiatlantic continent,' which existed during the earlier Tertiary. At first because of some paleontological facts noted by Schlosser, I believed that this continent could have transmitted Eocene mammals from South Africa to Europe, an idea now defended by Ameghino and Osborn; but in 1893 I modified my opinion and set forth the hypothesis that no Eocene placental mammals had existed either in Archamazonia or in Æthiopian Africa. The ancient continent uniting Archamazonia with Africa I named Archiatlantica in 1890, using in 1892 the term Helenis, and in 1893 that of Archhelenis, with the purpose of preventing confusion with the 'Atlantis' a hypothetical land bridge between South Europe and Central America proposed by Unger.

I will not repeat here what I have said elsewhere as to the intimate relation between the fresh water faunas of Brazil, Guiana, and of equatorial Africa, but I shall make some remarks on the geographical distribution of the fresh-water mussels. North America agrees in its Unionidæ with Eurasia, the genera *Unio*, *Margaritana* and *Anodonta* being predominant. The archiplatic element of South America is formed only by the genus *Unio*, and by a section of it which has no representatives in the holarctic region, forming the subgenus *Niæa*, which is found also in New Zealand and Australia. The numerous presumed genera of *Unio* now admitted in North America all agree in the characteristic sculpture of the beaks, which is quite different in *Niæa*. I consider, therefore, *Niæa* as a genus and the North American sections of *Unio* only as subgenera. In the archhelenic region we have representatives of *Unio* which are more intimately allied to *Niæa* than to *Unio*, no Anodontas, but very numerous representatives of the Mutelidæ. The South American 'Anodonta' are all *Glabaris*, a genus of Mutelidæ allied to *Spatha* of Africa.

Considering the geological history, we find the precursors of the actual North American Unionidæ as far back as the Jurassic period, and what we know of fossil mussels of New Zealand and Archiplata are only *Unios* of the *Niæa* section. On the other hand, Cretaceous deposits of Bahia show us representatives of *Glabaris* and *Mycetopus*. The actual conditions of distribution therefore predominated even in the Mesozoic time, and no explanation can be given of the intimate relation between the fresh-water faunas of tropical Africa and South America than the hypothesis of an ancient land bridge; supposing that these faunas were only the remains of an ancient cosmopolitan tropical fauna, the paleontological evidence should be totally different.

In regard to the geological distribution of the mammals of South America, the opinions of the respective authors are very divergent. There is, however, one point of which there can be no doubt, *i. e.*, the Pliocene exchange of North and South American types. It must be decided by North American zoologists whether this interchange has commenced at the close of the Miocene or only in the Pliocene. We may therefore consider as Pliocene the Argentine Araucanian formation, where the northern Artiodactyla and other North American immigrants first appear; the Entrerian formation, containing the neotropical forms must then be Miocene. This formation was considered by Ameghino Eocene (1889), or Oligocene (1898), and by the writer (1898), Miocene. In favor of his opinion Ameghino quotes the result of the study of G. Alessandri on the fossil selachian teeth of Entrerios which he believes to be Eocene. Mr. A. Smith-Woodward, to whom I have sent the material of our museum, writes me: "I conclude that the formation cannot be earlier than Miocene and is probably Pliocene." I have called attention to the fact that in the Entrerios deposits occurs *Monophora darwini*, a Scutellid with perforated disk which is common in the corresponding formation of the north Patagonian coast. No Scutellidæ with perforations of the disk are known earlier than the Miocene. On the other hand, the Mollusca of this formation are almost all extinct species and therefore I cannot believe it Pliocene.

Zittel in his 'Manual' has well explained the relations between the two American mammal faunas. I am, however, disposed to believe, contrary to him and to Ameghino, that the genus *Didelphys* in South America appears as a member of the North American immigration. If derived from the Patagonian Microbiotheriidæ, as suggested by Ameghino, this genus may have issued in the earlier Eocene time from Patagonia and Archinotis and, after having reached Europe in the Eocene and North America in the Miocene, turned to South America in the Pliocene. If Ameghino is right, the Proboscidia are derived from the Eocene Patagonian Pyrotheriidæ and, after having appeared in Europe and North America, returned to Argentina during the Pliocene in the form of the Mastodon.

If this migration is a relatively well established fact, it is quite doubtful in what manner Patagonia received its rich mammalian fauna in the Laramie period. Florentino Ameghino pointed out that this must have occurred by means of a land-bridge which united both Americas at the beginning of the Tertiary period. On this matter there has been a discussion between Ameghino and the writer in the *Revista Argentina de Historia Natural*, Vol. I., Buenos Ayres, 1891, p. 122 ff. and p. 281 ff., in which I have combated this hypothesis. The fresh-water faunas of the two Americas, as I have shown, are so completely different that only a prolonged and absolute separation can explain the fact; the geological history of both North and South America demonstrate an enormous development of the Cretaceous Ocean, separating the two Americas, and in the Tertiary period the North American territory increased but slowly. This presumed primitive connection of the two Americas is not at all supported by facts, but only based on the predominance of wrong ideas of the history of the Australasian Territory. The Eocene mammals of Patagonia and North America certainly do not justify this hypothesis. The Eocene faunas of Reims and

Puerco, although these localities are much more distant from each other than North and South America, correspond closely, but the characters of the earliest Tertiary Patagonian and North American mammalian faunas are quite divergent. We find nothing of the Toxodontia, Typotheriidæ and true Edentata in North America, and nothing of the Artiodactyla, Perissodactyla, Amblypoda, etc., in Patagonia. The orders and families which *are* represented in both Patagonia and North America may be such as were distributed over the whole area occupied by placental mammals in the Laramie period.

The third line of migration according to Ameghino and Osborn was determined by the land masses which connected Brazil and Africa. In my papers, and especially in the discussion with Ameghino, I have insisted upon the value of this Eocene land bridge, but I do not believe that it has served for the distribution of mammals, as I believe that Archamazonia was in the greater part of the Tertiary separated by the ocean from Archiplata. In this case Brazil has received mammals only in the Pliocene time, when the communication with Africa had long ago been interrupted. I have examined the deductions of Ameghino and Osborn with the purpose of verifying the facts proving their opinions, but these seem to be very insufficient. Osborn refers to the Pangolins and Aard Varks of the Æthiopian region as introduced from South America 'via Antarctica.' It must, however, be noted that these Edentata of the old world occur also in Asia and that they belong to the Nomarthra, while all the Patagonian representatives are Xenarthra. Both may be derived from a common Australasian ancestor, but if the South African Edentata had been derived from the Patagonian Eocene fauna, they should be Xenarthra. The genus *Orycteropus* occurs also in the Miocene of Samos, and may have immigrated both to Samos and to Africa from its Indo-australian home. It may be observed here that I have shown that the claw of the Dasypodidæ develops in the form of a hoof, and it is wrong to classify the Xenarthra with the Unguiculata, as they are Ungulata. The Proboscidea and Hyracoidea are not Patagonian mammals at all, although in the Patagonian Laramie or Pyrotherium fauna the Pyrotheriidæ and Archæohyracidæ offer relations to the two above-mentioned living families. The case is the same with the sole Patagonian Insectivore, the genus *Necrolestes*, somewhat comparable with the Chrysochloridæ of South Africa. Evidently the few representatives in the Patagonian Eocene of the Insectivora, Prosimiæ and Hyracoidea are the isolated members of groups which were well represented in other regions then in connection with Patagonia. Thus the Chrysochloris argument for the Patagonian-South-African migration is not better than the hypothesis of a land-bridge uniting the Antilles with Madagascar, the sole localities where representatives are found to-day of the genus *Centetes*, which occurs also as Wallace affirms in the European Tertiary.

The intimate relations between the fresh water faunas of Africa and Brazil, and the colossal difference which exists between the fresh water faunas of Archamazonia and Archiplata, prove that both territories during the greater part of the Tertiary were separated quite as completely as the two Americas. In this case the mammalian fauna of Patagonia may have reached Ecuador or Colombia by means of the upheaval of the Andes, but not Brazil, and both Brazil and the Æthiopian region may have been without mammals and especially placental mammals, during the Eocene. When toward the close of the Eocene this land-bridge was submerged, there already existed many types that have been conserved until our time, and thus we find existing on the Central American and Brazilian coasts the same species of mangrove plants, and with them numerous identical forms of Crustacea, Mollusca, etc.; the distribution of Manatus must also be cited here.

We now turn to the relations of South America with Australia and New Zealand. As the views put forth on this point by Hutton and the writer seem to be now generally accepted, there is no reason for discussing the question here. It may be observed, however, that not only does the fresh-water fauna give evidence of an antarctic land bridge between Australia, New Zealand and Patagonia, but also numerous other zoological as well as botanical and paleontological facts. Osborn says only that this migration established the links with Australia, 'bringing in Marsupials, both polyprotodont and diprotodont.' Ameghino (Censo, p. 250) says that on this vast antarctic land was distributed the cretaceous mammalian fauna which he has described. No other conclusion is logically possible, and we cannot doubt that the Eocene fauna of the Australian region, though not at all known to-day, must have been very analogous to and in part identical with the Patagonian.

The different adaptive radiations of orders and families have given a very different aspect to the existing faunas of Australia and Patagonia, in Australia only Monotremates and Marsupials having survived, in Patagonia principally histricomorph Rodents and Edentata. The existing fauna of Australia, New Guinea and other allied islands has received by Miocene immigration some placental mammalia, as *Canis* and *Uromys* in Australia, *Sus* and *Uromys* in New Guinea, and other genera in the Moluccas. This proves that Australia and New Guinea, at least during the Miocene, continued to be connected with Asia as in the foregoing periods. There existed therefore in the earlier Tertiary a continuous land mass from Antarctica and Patagonia, via Australia and Asia, to Europe and North America. This enormous territory, my Eurygæa, was the birthplace of the placental mammals. The Stenogæa (or Archhelenis) extending from tropical South America to Africa, Madagascar and Bengal was in the Eocene without mammals.

It is certain that we have to-day no knowledge at all of the Eocene mammals of Australia, Brazil and Africa, but from the facts given it seems to be highly probable that future discoveries may confirm what we expect.

Paleophytical studies have given evidence of a great resemblance between the Cretaceous floras of North America and Eurasia. According to Fr. Kurtz, the same flora appears also at St. Cruz, Patagonia em Cerro Guido (*Revista Museu La Plata*, Vol. X., 1899, p. 43 ff.). According to the facts given above, this flora cannot have reached Patagonia from North America, as the two Americas were then separated and no South American continent existed. It is also impossible to admit that a land bridge formed by the Andes served for the migration, because these did not then exist, as the Cretaceous marine beds of the Andes prove. There must then have been a connection between the Antarctic Cretaceous continent, the Archinotis of the writer, and Asia. It may be observed that the genus *Quercus* was represented in the Cretaceous beds of both Patagonia and Australia, where to-day it has no representative. What has occurred in the case of *Quercus* and other genera in both Australia and Patagonia and what is observed in Patagonia with reference to mammals may have happened also in Australia to the earlier placental mammals. Further, it must be remembered that Australia, and South America also, developed by coalescence of different parts, each of which had its own history.

I may note here one more fact referring to the fresh water fauna: the dispersion of the cyprinoid fishes. These Holarctic fishes did not reach Australia, already isolated by the sea, but invaded Africa and Madagascar. Lemuria must therefore have persisted in connection with Asia, when the Australian region was already isolated. Thus Africa offers the same mixture of ancient indigenous elements and Neogene immigrants as Argentina and Southern Brazil, on account of the intrusion of archamazonic immigrants. Had this invasion occurred in the Eocene period, the Cyprinidæ would have reached Brazil; supposing it to be Pliocene, these fishes would not have reached Madagascar. Probably Africa received its placental mammals at the same time that the invasion of Cyprinidæ into Africa took place, one of the most remarkable events in zoogeography.

We have no knowledge at all of the Cretaceous and Eocene mammals of Brazil, Guyana, Africa and Australia; it is impossible to give a complete history of the mammals with incomplete materials. But combination of the known facts makes it probable that during the Cretaceous and Eocene period Archhelenis, or Stenogæa, was without placental mammals and that their origin was in Eurygæa. In regard to the flora the same holds good for many families of wide distribution, as for example the Cupuliferæ.

With reference to the terms used by Blandford, Lydekker and the writer, it must be said that the intention of the first two was to give names to *existing* zoogeographical regions, while the terms introduced by me refer to *supposed*, *ancient* zoogeographical and geographical regions. The two great Cretaceous continents Eurygæa and Stenogæa may have existed also during a part of the Eocene period and then dismembered. From Stenogæa, or Archhelenis, were separated first Bengal and then Madagascar, while Archamazonia after the loss of the connection with Africa consisted of Archiguyana and Archibrazil. Eurygæa split into (1) Archiboreas corresponding to the actual holarctic region and (2) Archinotis from which, in the Eocene, Archiplata was separated.

The comparison of the distribution of the mammals with the fresh water fauna makes especially evident the differences in the geographical conditions which must have determined their distribution. While the distribution of the existing types of mammals is a result of changes in geography during Tertiary time, the most fundamental facts in the distribution of the fresh-water fauna dates from the Mesozoic epoch. The fresh-water fauna of Chili preserved such a remnant of the Cretaceous fauna almost intact, and even the connection between the two Americas has not at all modified the South American fresh-water fauna. On the other hand, representatives of the Archamazonian fauna, in correlation with the geographical modifications of Central America and the Antilles have invaded the southern parts of the nearctic region. Thus in the Rio Usumacinta of Mexicao beside Cyprinidæ and Chromidæ we find also Characinidæ and Lepidosteus, also species of *Glabaris* intermediate between the northern Unios and Anodontas. There is a further difference in the distribution of mammals and fresh-water mussels. The former migrate on land bridges in both directions, the fresh-water fauna generally in only one, due to the opportunity given by the currents. Thus although there was an invasion of Cyprinid fishes into Africa there was no corresponding emigration of Æthiopian types. A similar fact is the sudden appearance of the Æthiopian faunal elements in the valley of the Nile, which occurred only at the close of the Pleistocene, as proved by paleontological facts. While the Pliocene connection of the two Americas was sufficient to modify the distribution of the mammals in such a way that without paleontological researches it would be impossible to recognize the origin of the different faunal elements, the fresh-water faunas have resisted almost unchanged all modifications in the configuration of the continent.

The fresh-water fauna is not only older but also much more conservative than the distribution of the mammals. One of the most striking examples of this is given by the history of Africa. While the characteristic mammals are Neogene immigrants and Lydekker proceeds quite correctly in making Africa an annex only of the Holarctic region, thus establishing his Arctogæa, with relation to the fresh-water fauna, Africa is a part of South America, somewhat modified by the Neogene invasion of Cyprinid fishes. If as regards mammals Africa belongs to Arctogæa, with relation to the fresh-water fauna it belongs to the Archhelenic region.

This example demonstrates *the absurdity of the present system of construction of zoogeographical regions and maps. We can construct maps of the different classes and orders but not at all of the animal kingdom, because the geological history of the different groups is quite different.* When Osborn says that it is one problem 'to connect living distribution with distribution of past time,' he says only what had been the leading idea of Wallace and of Engler in their eminent works on zoo- and phytogeography, but when he continues 'and to propose a system which will be in harmony with both sets of facts,' he proposes a problem just as contradictory as would be the construction of descriptions and figures referring at the same time to egg, larva, nympha and imago of an insect. The works on 'zoogeography' are almost exclusively discussions of the distribution of mammals and birds, and the few words spent on other classes are only ornamental supplements. A wrong method cannot give valid results. For the exploration of the zoogeographical relations and regions of the beginning of the Tertiary and of the preceding Mesozoic epoch it is necessary to study and to discuss the more ancient classes and, as I have insisted for ten years, principally the fresh-water fauna.

H. von Ihering.

São Paulo, July 20, 1900.

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*A HISTORY OF THE DEVELOPMENT OF THE QUANTITATIVE STUDY OF VARIATION.**

The quantitative study of variation has for its object the investigation of evolution by exact, quantitative methods. The study demands a mathematical method as well as a biological subject matter; consequently the development of the science has proceeded along two main lines—the one biological and the other mathematical. Accordingly, the history of the development of the quantitative method involves a consideration of both the study of variation and the elaboration of the necessary method.

The fact of variation has been recognized since man began to think and to appreciate that in stature, color and mental capacity his fellow-men are diverse. The way for quantitative studies in biology was paved by the mathematical studies on the variation of measurements which engineers and astronomers found it necessary to make for their own purposes. These mathematical studies led to the discovery and elaboration of the law of error by Gauss and others—and this law is the corner-stone of the quantitative biological studies.

The application of the law of error to organic variation was, apparently, first made by an anthropological statistician, of the early part of the century, named Quetelet. In his book, entitled 'Lettres à Son Altesse Royale le Duc de Saxe-Coburg et

* Being part of the report of the Committee of the American Association for the Advancement of Science on the Quantitative Study of Variation.

Gotha sur la théorie des probabilités appliqués aux sciences morales et politiques,' published in Brussels, 1846, and translated into English by O. G. Downes, 1849, Quetelet applied the mean and probable error to the designation of the peculiarities of different races of men ; and he even compared an observed distribution of frequencies of human statures with a theoretical one calculated from the mean and the probable error by the use of the formula,

$$y = \frac{2}{\sqrt{\pi}} \int_0^t e^{-t^2} dt.$$

The possibilities of an extension of this method of quantitative analysis to biological variation in general were, however, during twenty years unrecognized, for the time was not yet ripe.

Meanwhile, on the biological side the clouds of a revolution were rising. During the fifties the variation of animals in nature was much discussed. In 1856 Wollaston wrote a book 'On the Variation of Species,' and at a meeting of the British Association, in the same year, Jenyns called for exact data on the variation of organisms. Then came the 'Origin of Species,' 1858, 1859, which used the facts of variation to enforce the conclusion of the mutability of species. At that time the study of the variation of species received a great impetus, but for forty years the observations have been for the most part qualitative or only roughly quantitative. Among the most important synoptic works on variation have been Darwin's 'Variation of Animals and Plants under Domestication,' 1868, and Bateson's 'Materials for the Study of Variation,' 1894.

To the rule that until a decade ago studies in variation were qualitative, the anthropological studies have formed a striking exception. Anthropologists have been forced to measure by the necessity of making fine discriminations, and have sought by statistical methods to get the most out of the resulting data. The first to advance beyond Quetelet was Francis Galton, cousin of Darwin, and already well known on account of his studies on heredity. In 1870, in his book on 'Hereditary Genius,' he used Quetelet's method of applying the law of error to organisms. He used it especially to get a quantitative definition of his grades of ability, A to G. In 1879, Galton made a further and important step. He pointed out that "an assumption which lies at the basis of the well-known law of 'Frequency of Error' (commonly expressed by the formula, $y = k \cdot e^{-h^2x^2}$) is incorrect in many groups of vital and social phenomena." The assumption which Galton combats is "that errors in excess or in deficiency of the truth are equally probable or conversely, that if two fallible measurements have been made of the same object their mathematical mean is more likely to be the true measurement than any other quantity that can be named." Galton goes on to show that this assumption cannot be justified in vital phenomena ; for example, in guesses at a color containing 8 parts of white, we are equally apt to err by selecting one with 16 parts and one with 4 parts, yet the error in one case is twice the error in the second case. Conversely, in two guesses at a mid tint, the most reasonable conclusion is not the arithmetic mean of the two, but the geometric mean. If the guesses are 4 and 16, the most probable value is not $\frac{4+16}{2} = 10$ but $\sqrt{4 \times 16} = 8$; for $4:8::8:16$. Galton then extends this case to biological measures in general and calls for a law of error based on the geometric mean. At his suggestion Mr. Donald McAllister worked out a more general form of the probability curve, applicable to a distribution of frequencies based on geometric error, and obtained the result,

$$y = \frac{1}{x\sqrt{\pi}} h^{-h^2 \log.^2 x}.$$

At about this time also, the anthropologist Stieda called attention in Germany to the application of the probability methods to anthropological statistics. His paper published in the *Archiv für Anthropologie*, Band XIV., entitled 'Ueber die Anwendung der Wahrscheinlichkeitsrechnung in der anthropologischen Statistik,' 1883, has had great influence in extending the use of the method. In this work the measure of variability is the probable error, here called the 'Oscillations Index.'

During the eighties, Galton, in a remarkable series of papers, developed the quantitative theory of individual variation. In 1885 he introduced a graphic method of determining the probable error, using his 'ogive' or normal curve of distribution of error. In connection with his studies on pedigree peas he developed the theory of the mid-parent, the law of regression of the progeny of extraordinary parents toward mediocrity, and the law of ancestral inheritance, according to which the mid-parent contributes one-half, the mid-grand-parent one-fourth, the mid-great-grand-parent one-eighth, and so on, of the whole heritage. In 1888, Galton made another important step. He obtained a method—somewhat rough, to be sure, because chiefly graphic—for measuring *correlation* between two organs. The measures of one organ, called subject, were taken, the mean found and the measures grouped into classes expressed in terms of the deviation from the mean divided by the probable error of the subject. The average of the corresponding measures of the other organ, called relative, was found, and the deviation of the average from the mean size of the organ was expressed in units of the probable error of the relative. The average (found graphically) of the ratios of the deviation of the relative divided by the deviation of the corresponding subject class gives the correlation-index sought.

The culmination of this epoch-making work of Galton was his 'Natural Inheritance,' 1889, which applied the quantitative methods he had elaborated to the data of human inheritance which he had himself gathered. The book is important, not so much for its new material, for much of the matter had appeared elsewhere, but because it called attention to the possibilities of the quantitative method applied to biology generally. But probably of even greater effect were Galton's personal suggestions to biologists such as Weldon and to mathematicians such as Pearson. At any rate, the beginning of the new decade saw the beginning of a wider interest in the quantitative study of variation; and the source of this wider interest can be traced directly to one man—*Francis Galton*.

While the impetus to the modern quantitative variation studies came from Galton, quantitative studies, in zoology at least, were not unknown before 1890. In our own country, Baird, Coues and J. A. Allen had measured numerous individuals of each of many species of mammals and birds and had published tables of measurements. Allen, in particular, had grasped the importance of the quantitative study of variation, had compared the average dimensions of mammals and birds from different parts of the country and had established* a law of relation between the size of individuals and their distribution which has proved very fertile.

As long ago as 1829, H. Milne-Edwards † gave a table of variations in size of various parts of the body of fourteen individuals of

* J. A. Allen, 'On the Mammals and Winter Birds of East Florida,' etc., Bull. Mnseum Comparative Zoology at Harvard College, 1871, and 'Geographical Variation among North American Mammals,' Bull. U. S. Geol. and Geog. Snrvey, Vol. II., 1876.

† *Annales des sciences naturelles* (1), 16, p. 87.

Lacerta muralis. Students of molluscs have also been led in a few instances to quantitative studies. One of the most important of these was that of Bateson, who showed by a series of measurements the gradual change in form of the cardiums on the terraces of an inland sea which is gradually becoming denser.

From 1890 on, the published works in the field we are considering became more numerous and appeared simultaneously in several countries and stimulated from various sources. It was early in this decade, too, that the remarkable series, by Pearson and his pupils, of mathematical contributions to the theory of evolution, began to appear. Since these papers profoundly affected biological work, it will be well to consider them first. We may then consider in turn the English biological school—especially the work of Weldon and his pupils—the continental biological work, and finally that of America.

In 1894 Professor Karl Pearson published the first of his valuable series of papers on the mathematics of evolution, entitled 'On the Dissection of Frequency Curves.' While the primary result of these investigations has as yet proved of no great service, the methods elaborated have formed the basis of all Pearson's later analysis. These methods consisted of the analytical investigation of the frequency curve by reduction to the first to fifth movements about an assumed vertical axis. The root of the mean square error was employed as the best measure of variability and was called the standard deviation.

Pearson's second paper: 'Skew Variation in Homogeneous Material,' 1895, is the basis of the newer quantitative methods. Starting with the recognition of the fact that the vast majority of biological frequency curves are not symmetrical but 'skew,' Pearson undertakes an analysis of distribution curves in general, gets a general formula and concludes that there are five types of curves altogether. These are the normal curve—which is symmetrical and has an infinite range; the symmetrical curve with limited range; the skew curve with range unlimited in both directions, with range limited in both directions, and with range unlimited in one direction and limited in the other. The analysis of skew frequency curves was not entirely new, for it had previously been made by an American, E. L. De Forest, of Connecticut. But Pearson's work, having especially a biological aim, has become generally adopted by biologists. In 1897 there was published, posthumously, an analysis of frequency curves by Fechner; but Fechner's treatment is much clumsier than Pearson's. Within recent years a fresh analysis of skew curves has been made by the English mathematician, Edgeworth in the Philosophical Magazine. Sheppard, too, has contributed methods of analysis of frequency curves. All these will doubtless eventually be of service to biologists.

Pearson's third paper, 1896, was devoted to the theory of correlation, which he placed on an analytical basis. His method of getting the index of correlation was a long one, which Duncker has greatly simplified in his paper published a year ago.

Pearson's fourth paper, published jointly with L. N. G. Filon in 1898, dealt with the probable errors of frequency constants and is of great importance for measuring precisely the degree of unreliability of any result. Pearson's later papers, many of which are published under the uniform title 'Data for the Problem of Evolution in Man,' have elaborated and extended the results of his earlier works.

The results of the last six years, then, have placed the analysis of biological frequency curves at once upon a satisfactory scientific basis. But the limit of improvement in the method of analysis is by no means reached.

Passing now to the biological results, we consider first the work done in England, for it was there, in the home of Galton and Pearson that the new methods found their first application. Of the papers of the new era the first is that of Weldon, 1890, entitled 'The Variations occurring in Certain Decapod Crustaceæ. I. Crangon Vulgaris.' Proceedings of the Royal Society of London, Vol. XLVII, pp. 445–453. This study was undertaken to test Galton's prediction * that selection would not alter the distribution of frequencies in any race. Weldon measured four dimensions in several hundred individuals, calculated the means and probable errors, compared the observed and theoretical frequencies and concluded that Galton's prediction is fully justified. He showed, in addition, that the variation in size of the organs measured occurs with a frequency indicated by the law of error and that the 'probable error' of the same organ is different in different races of the same species.

Next Weldon obtained measurements of the variation of the shrimp *Palæmonetes varians* in Plymouth, which have lately been made the basis of comparison with our American shrimps by Duncker and by Johnson and Hall. These comparisons have established that the otherwise very similar English and American shrimps have modal numbers of rostral spines which are respectively 4 and 8. In 1892 Weldon studied correlative variation in the prawn *Crangon vulgaris* and drew the conclusion that a wide knowledge of the specific constants would give an altogether new kind of knowledge of the physiologic connection between the various organs of animals.

In 1893 Weldon published a fourth paper, on correlated variations in *Carcinus mœnas*, in which he dealt with ratios of various dimensions of the body to the carapace length. It was in these studies that Weldon came across a distribution of frequencies which did not conform with the theoretical distribution, and which Pearson subsequently resolved into two symmetrical curves. Weldon found the coefficient correlations between similar organs in different races to be closely alike.

* Natural Inheritance, pp. 119–124.

While Weldon was making these studies, Bateson and Brindley published (1892) their quantitative studies on the length of the forceps of male earwigs, on the length of the cephalic horns of a rhinoceros beetle and on the length of the mandibles and the elytra of a stag beetle. In the first two cases there was a marked discontinuity in the variations. Thus the forceps had modes at 3.5 millimeters and 7 millimeters, and the horns had modes at 4 and 9.5 millimeters. In 1895 Bateson gave statistics of the marvelous variation in color of a chrysomelid beetle, but the data hardly admitted of exact quantitative analysis.

In 1895, Weldon presented to the Royal Society his first report of the committee for conducting statistical inquiries into the measurable characteristics of plants and animals. In this report he gives the results of studies on selective destruction of the rock crab. The climax of the studies of Weldon and his pupil, Thompson, on the rock crab is his presidential address before the British Association (1898) in which he showed that the proportional size of the frontal margin of the crab's carapace had at Plymouth, during the preceding five years, diminished five per cent. Consequently he has been able by means of the quantitative method to measure a real evolutionary change. Moreover, he has been able to put his finger on the cause of this change, for he showed that the silting up of the harbor of Plymouth, and the greater quantity of mud in the harbor, tends to kill off the crabs with broad gill-openings and to let survive only those with narrow gill-openings and a narrow gill (or frontal) margin. The expectation, then, that quantitative studies would quickly demonstrate that evolution is going on rapidly in certain instances to-day has been realized.

Another of Weldon's pupils, Warren, has provided statistical data on variation in the crab *Portunus*, and on the variation of ancient, barbarous races as compared with modern civilized ones. More recently he has measured quantitatively the effects on the little crustacean *Daphnia* of various external conditions. Vernon, likewise, has given quantitative data on the effects of external conditions on the development of echinoid larvæ and on echinoid hybrids. Finally, the recent confirmation by Galton of his law of Ancestral Inheritance demands brief mention.

The continental school of variation students includes chiefly botanists. Very early (1887) F. Ludwig, of Greiz, began to make quantitative studies on the variation in the number of ray flowers of the white daisy. These studies he continued and extended to other species, and has published the results in a series of papers appearing in the *Botanisches Centralblatt* from 1895 to the present time. He finds that the variation curves of plants are more frequently multimodal than are those of animals. Ludwig has published two comprehensive papers, in 1898 and 1900 respectively, which have served to extend a knowledge of the new method. At Amsterdam, de Vries has applied statistics to his experimental, chiefly *selective*, plant breeding. He has produced new races of certain very variable species within two to four years. Verschaffelt, a student of de Vries, did good service in calling attention to the importance of the coefficient of variation (or the index of variation divided by the average) for comparative purposes. Verschaffelt also suggested an ingenious measure of skewness, which is very simple but has been largely replaced by Pearson's index. Important work has also been done by L. MacLeod, of Ghent, Belgium, and his pupils, in papers published in Dutch in the *Botanish Jahrboek.*

Among the continental zoologists Heincke was the first in the field. He has applied statistics especially to questions relating to the existence of local races of fishes, and especially the herring. George Duncker, a student of fishes, has been occupied with biological statistics since the early part of the decade. He has written an excellent general treatise on the subject, (1899) in which the more important methods of Pearson are simplified and thus made more generally available. In Italy, Camerano has made a beginning with the quantitative methods.

In America quantitative studies of human variation have been made by anthropologists incited by the work of Galton. Prominent among these are Bowditch, Porter and Boaz. Minot also has made use of Galton's methods. Within late years Bumpus (1897–1899) has applied Galton's methods to variation of *Necturus*, and to the problem of the relation of variation to environment and to selection. Eigenmann and his student, Moenkhaus, have given data on the differences in the *mode* of certain fish characters in successive years and in different environments. The writer and his pupils, Blankinship, Brewster, Bullard and Field, have contributed certain quantitative data upon some of Darwin's laws of variation and upon correlation. The writer has also published a small book on the newer methods which, containing the principal formulæ and tables for calculating curve constants, it is hoped may be found useful by students of the new methods.

To sum up, the quantitative study of biology, the modern impulse to which we owe to Galton, has been furnished with good methods by Pearson. Already the application of these methods has borne fruit in our knowledge of the types of biological frequency curves, and their change with changing place and environment. The idea of correlation has received a precise definition. The results of experimentation have been quantitatively expressed. The rôle of natural selection, the method of evolution and the laws of inheritance are being discovered. Already we are able to predict greater results from the quantitative method in biology, especially where combined with experimentation, than any which have yet appeared.

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PLANT GEOGRAPHY OF NORTH AMERICA.

COMPOSITION OF THE ROCKY MOUNTAIN FLORA.

In Southern Wyoming the Great Plains extend across the continental divide, making a break in the Rocky Mountain chain, and dividing it into two groups, the Southern and the Northern Rockies. The former are for the greater part in the State of Colorado, but extend into northern New Mexico as well as southern Wyoming. The Wasatch and Uintah Mountains, although separated from the main claim by the Green River Basin, may also be noted here.*

The Northern Rockies begin in northern Wyoming, but have their best development in western Montana, northern Idaho, western Alberta and eastern British Columbia. The chain also extends into Alaska and Yukon Territory, but the flora of this region is partly very little known and so merged into the Pacific Coast flora that it deserves a separate treatment. Some isolated mountains, as for instance the Black Hills of South Dakota and the Little Rockies and Bear Paw Mountains of Montana, may also be mentioned here.

*The mountains of southern New Mexico and Arizona may also be accounted to the Rocky Mountain system, but their flora is so different and contains so many Mexican and Sonoran elements that it is better to exclude them from this discussion.

The flora of the two groups is essentially the same, but some differences are found. These are most evident in the coniferous vegetation. So are for instance *Pinus edulis*, *Pinus aristata*, *Picea Parryana* and *Abies concolor* confined to the Southern Rockies, while *Pinus Murrayana*, *Picea Columbiana* and *Abies grandis* take their place in the Northern. *Psudotsuga mucronata*, *Picea Engelmannii* and *Pinus flexilis* are equally common in both regions.

The flora of the mountain regions is made up of the following elements:

1. The Endemic Flora of the Rockies, which constitutes the largest element. In Montana it is represented by 33 per cent. of all the species and in the Southern Rockies the proportion is much larger.

2. The Transcontinental Flora, made up mostly of hydrophilous plants.

3. The Boreal Flora of North America, which in British America is more or less transcontinental, but in the United States is found principally in the mountain regions. It is made up mostly of hylophilous plants, but also represented by some hydrophilous ones, as for instance members of *Cyperaceæ*, *Salicaceæ* and *Ericaceæ*.

4. The Arctic Flora, found only on the tops of the highest peaks at an altitude of over 3,000 m. in Montana and over 4,000 m. in southern Colorado.

5. The Cascade Mountain Flora, which merges with that of the Rockies in British Columbia and partly extends south into Montana and Idaho.

But in discussing the flora of the Rockies, one must not only take in consideration that of the mountain regions, but also that of the intermingling plains, valleys and foothills. If this is done, several new elements must also be considered.

6. The Flora of the Great Plains. The Great Plains consist of high dry tablelands and make up a large portion of Saskatchewan, Assiniboia, eastern Montana

and Colorado, eastern and central Wyoming, and western Dakotas, Nebraska and Kansas. They have a flora of their own, mostly consisting of xerophilous plants, but in the valleys along the water courses are brought in besides the transcontinental flora mentioned above, also a few of another element, viz:

7. The PRAIRIE FLORA OF THE MISSISSIPPI VALLEY. The species of the typical Alleghanian flora found in the Rockies are so few that they may practically be disregarded. In all cases they are also represented in the Prairie flora.

8. The FLORA OF THE STAKED PLAINS, which extends into southeastern Colorado and northeastern New Mexico. The Staked Plains, with their best development in northwestern Texas, are but a southern extension of the Great Plains, but contain numerous plants not found on the latter, so that its flora may well be treated separately.

9. The SONORAN FLORA, the general flora of the table-lands of northern Mexico, Arizona and southern and western New Mexico.

10. The GREAT BASIN FLORA of Nevada, Utah, southern Idaho and southeastern Oregon. This can almost be regarded as a desert flora. It is also met with outside of the Great Basin, especially in many places in the Green River valley of Wyoming, Utah and Colorado.

11. The COLUMBIA VALLEY FLORA. This flora extends along the headwaters and tributaries of Columbia River into the Rockies of Idaho, Montana and British Columbia.

A flora made up of so many elements must naturally be very varied and exceedingly interesting. A comparison may well be made with that of the Alleghanies on one hand and that of the Cascade Mountains and Sierra Nevada on the other. If this is done we find that the flora of the Rockies resemble more the latter than the former.

The bulk of the forest of the Rockies is made up of Conifers. Most of these are common to the region and mountains of the Pacific Coast, but none of the trees are found in the Alleghanies or around the Great Lakes. The White Spruce, *Picea Canadensis*, has been reported from northern Montana and Alberta, but I think erroneously so. Probably *P. Columbiana*, which resembles it in habit and the glabrous branches, has been mistaken for it. *P. Columbiana* is otherwise much more closely related to *P. Engelmannii*. Two prostrate shrubby species of *Juniperus*, *J. Sibirica* Burgsd. and *J. postrata* Pers. range across the continent. Both are subarctic and subalpine. Besides these none of the Rocky Mountain conifers are found in the East, although they are often represented there by closely related species.*

*List of the Rocky Mountain Conifers and their representatives in the East and on the Pacific Coast

Rocky Mountains.	East.	Pacific Coast.
Pinus flexilis ¶ / *Pinus albicaulis*	....	*Pinus flexilis* / *Pinus albicaulis*
Pinus monticola	*Pinus Strobus*	*Pinus monticola* / *Pinus Lambertina*
Pinus edulis	....	*Pinus monophylla*
Pinus aristata	....	*Pinus aristata* / *Pinus Balfouriana*
Pinus ponderosa / *Pinus scopulorum*	*Pinus resinosa*	*Pinus ponderosa*
Pinus Murrayana	*Pinus Virginiana* / *Pinus divaricata* / *Pinus echinata*	*Pinus Murrayana* / *Pinus contorta*

Among the deciduous trees and shrubs, the number of species common to the Rockies and the East is much larger. Many of these common species are boreal, but some are truly transcontinental or nearly so.

Of the SALICACEÆ about three-fifths of the Rocky Mountain species are endemic or western. The rest are nearly all boreal. The only ones that cannot come under these categories, as far as I can remember, are *Salix Bebbiana*, *S. candida* and *S. cordata*. The eastern *Populus deltoides* is represented in the Rockies by a western variety.

Of BETULACEÆ, *Betula papyrifera*, *B. glandulosa*, *Alnus Alnobetula* and perhaps *A. incana* are found both in the Rockies and in the East. The other four Rocky Mountain species are western.

Of FAGACEÆ, *Corylus rostrata* is common to the Rockies and the East. Besides by this species, the family is represented in the region by a few endemic low species of *Quercus* of the White Oak group.

ULMACEÆ is represented by three or four species of *Celtis*, of which *C. occidentalis* is found in the East. *Ulmus Americana* is found here and there in the valleys of the Great Plains, but scarcely reaches the Rockies.

All woody species of HYDRANGIACEÆ, GROSULARIACEÆ, ROSACEÆ, POMACEÆ, DRUPACEÆ, PAPILIONACEÆ, RUTACEÆ, RHAMNACEÆ, ACERACEÆ, CELASTRACEÆ and ANACHARDIACEÆ are endemic or western, except four species of *Ribes*, four of *Rosa*, *Rubus strigosus*, *Dasifora fruticosa*, *Sorbus sambucifolia*, *Prunus Americana*, *P. Pennsylvanica*, *Amorpha fruticosa*, *Rhamnus alnifolia*, *Acer Negundo* and *Rhus glabra*, which are also found in the East.

The two species of VITACEÆ found in the Rockies, viz., *Vitis vulpina* and *Partenocissus quinquefolia* extend to the Atlantic coast, and so also the three species of ELÆGANACEÆ.

Taken as a whole, scarcely 20 per cent. of the woody plants of the Rockies are found in the Alleghanies or around the Great Lakes. Nearly all those common to both regions are transcontinental or boreal species. If on the contrary, the woody flora of the Rocky Mountains were compared with that of the mountains of the Pacific Coast, one would find that at least 50 per cent. of the former would be represented in the northern Cascade Mountains, which in British Columbia are more or less contiguous to the Rockies.

It has been impossible for me to make a detailed comparison of the general flora of the Rockies with that of the East on one hand and with that of the Pacific States on the other. In my catalogue of the flora of Montana and the Yellowstone Park, I made such a comparison, and I think that the conclusion reached there with some modification may serve for the whole Rocky Mountain region. The catalogue contains 1,976 species and varieties. Of these 487 are found both east and west of the mountains and 268 only east thereof, or in other

Larix occidentalis *Larix Lyallii*	*Larix laricina*	*Larix occidentalis* *Larix Lyallii*
Picea Parryana *Picea Engelmannii* *Picea Columbiana*	*Picea Canadensis* *Picea rubra* *Picea Mariana*	*Picea Silchensis* *Picea Engelmannii* *Picea Columbiana*
Pseudotsuga mucronata	(*Tsuga Canadensis*)	*Pseudotsuga mucronata*
Abies grandis *Abies amabilis* *Abies concolor* *Abies lasiocarpa*	*Abies balsamea*	*Abies grandis* *Abies amabilis* *Abies concolor* *Abies lasiocarpa, etc.*
Thuja plicata	*Thuja occidentalis*	*Thuja plicata*
Juniperus scopulorum *Juniperus Knighti*	*Juniperus Virginiana*	*Juniperus California*
Juniperus occidentalis *Juniperus monosperma*	....	*Juniperus occidentalis* *Juniperus monosperma, etc.*
Juniperus prostrata	*Juniperus prostrata*	*Juniperus prostrata*
Juniperus Sibirica	*Juniperus Sibirica*	*Juniperus Sibirica*
Taxus brevifolia	*Taxus Canadensis*	*Taxus brevifolia*

words 755 of the Montana and Yellowstone Park species are extending eastward. This includes transcontinental and boreal plants, as well as plain and prairie species. Of these not more than half or not fully 20 per cent. of the whole number reach as far east as the Alleghanies or the Great Lakes. If the flora of Colorado should be compared in a similar way with that of the east, one would find that a much smaller number of species was common to the two. It is therefore safe to say that not 20 per cent. of the plants of the Rockies are found in the Alleghanian region and that these consist almost exclusively of transcontinental and boreal plants.

In comparing Montana with the Pacific Coast, I found that 487 (mostly transcontinental and boreal plants), plus 520 (mostly Columbian and Cascade Mountain plants) or 1,007 species or nearly 51 per cent. of the plants of that State are also found west thereof. These figures can not be taken as a fair average, for in Colorado we find fewer plants that are common to that State and the Pacific Coast. I should judge that even 20 per cent. would there be a high number. I think, however, that it is safe to say that between 30 and 40 per cent. of the plants of the Rockies are also found in some part of the Pacific Coast region.

The families best represented in the Rock Mountain flora are the following in the order here given: COMPOSITÆ, GRAMINEÆ, PAPILIONACEÆ, CYPERACEÆ, SCROPHULARIACEÆ, ROSACEÆ, CRUCIFERÆ, RANUNCULACEÆ, CICHORIACEÆ, POLYGONACEÆ, ONAGRACEÆ, UMBELLIFERÆ.

In Montana the composites (with CICHORIACEÆ and AMBROSIACEÆ excluded), constituted about $15\frac{1}{2}$ per cent. of the species of flowering plants, the grasses about 10 per cent., the pea family 6 per cent., the sedges and rushes 5 per cent., etc. Of COMPOSITÆ over 45 per cent., of GRAMINEÆ over 41 per cent., and of PAPILIONACEÆ nearly 50 per cent., but of CYPERACEÆ only 25 per cent. are endemic species.

In Montana the following genera are represented by the largest number of species: *Carex, Senecio, Erigeron, Potentilla, Pentstemon, Astragalus, Poa, Aster, Ranunculus, Salix, Artemisia, Polygonum, Castilleja* and *Eriogonum.* In the whole Rocky Mountain region these genera will have nearly the same order, except that *Pentstemon* and *Polygonum* have to be moved slightly further down and *Eriogonum* a little higher in the scale.

P. A. RYDBERG.

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*A TERTIARY CORAL REEF NEAR BAINBRIDGE, GEORGIA.**

THIS fossil coral reef is located near Russell or Blue Spring, about four miles below Bainbridge, Decatur County, Georgia, along the Flint River. My attention was first called to the presence of reef corals in this vicinity by finding two species, collected by Professor Raphael Pumpelly, in the United States National Museum. These species were described by me in Monograph XXXIX. of the United States Geological Survey, under the names *Stylophora minutissima* and *Astrocœnia pumpellyi*, both species being compared with species from the Antiguan Oligocene. Subsequently, in February, 1900, Mr. Alfred H. Brooks, of the United States Geological Survey, brought me from the same locality a species of *Orbicella,* which I identified with an Antiguan species and specimens of *Astrocœnia pumpellyi.* Because specimens of *Pecten* (*Pseudamusium*) *ocalensis* Dall and *Orbitoides* were brought with the corals, I referred the latter to Dall's Ocala horizon of the Vicksburgian Oligocene. It will be shown later that I was mistaken as to the stratigraphic position of the corals.

Because of the interesting character of the corals from Russell Spring, I requested

* Published by permission of the Director of the U. S. Geological Survey.

permission from the Director of the Geological Survey to visit the locality during the present field season.

Three localities where fossil reef corals of the same horizon are found were studied. The best and most important one is on the left bank of the Flint River, about a quarter of a mile below where Russell Spring empties into the river. About a half mile farther down stream on the right bank is another exposure. At Cherry Chute, some three miles below Bainbridge and about a mile above Russell Spring, is another exposure of the same rock on the right bank of the river. The following section was observed at the locality just below Russell Spring and the locality one-half mile farther down stream. It should be stated that the Vicksburgian Oligocene was not seen at the latter locality.

1. Yellow clay and yellow argillaceous limestone, composed largely of comminuted shells, spines of sea-urchins. Fossils fairly numerous, but only a few species are represented; they are a large species of *Orbitoides*, several species of echinoids, *Echinocyamus* is one of the genera, and *Pecten* (*Pseudamusium*) *ocalensis* Dall. The stratum belongs to the Vicksburgian Oligocene. Its upper surface is very irregular, showing decided evidence in favor of Professor Pumpelly's conclusion that the Vicksburg is separated by an erosion unconformity from the succeeding Chattahoochee. Thickness (to water's edge) a few feet.

2. Bluish or whitish sandy clay, sometimes purplish, rarely greenish. In this bed large limonitic segregations are abundant. The segregations occur in pockets often of many feet in horizontal extent and several feet thick. The purplish clay in places contains carbonaceous particles. Thickness variable, from 5 to 10 feet or even more.

3. Cherty limestone, or chert—the fossil coral reef. In the section this does not appear as a connected stratum, but in large detached masses, which very often have rolled down the incline to the river, but some are *in situ*. Dr. Dall identified from this bed for Professor Pumpelly *Orthaulax* and *Amauropsis burnsi*, referring it to the Chattahoochee horizon.* Molluscan remains are abundant, but the state of preservation is poor. The shells are completely silicified, or there are only surface casts or chalcedonic internal fillings. *Pecten*, *Venus*, *Xenophora* and *Natica* are common genera. A very large portion of the rock is composed of coral heads, some more than a foot in diameter. The specimens of corals are more easily removed from the matrix in which they lie than are the mollusks. Thickness, 3 feet.

At Cherry Chute the thickness certainly exceeded 8 feet.

4. Reddish sands, containing some gravel, 8 feet.

The bed of the greatest interest is No. 2. The corals from it belong to the basal portion of the Chattahoochee and not, as I once supposed, to the Vicksburg.

The following is a rough characterization of the corals found in the stratum:

Caryophylliidæ (probably Paracythus)	1 sp.
Other simple corals (several species)	2 or more.
Bifurcating forms	2
Calamophyllia	1
Oculinidæ	1
Stylophora, probably	3
Astrocœnia, probably	2
Orbicella, at least	3
Siderastrea	1
Mesomorpha?	1
Isoporidæ (Madreporidæ Auct.), at least	2
Poritidæ, about	3
Alveopora	1 or more

and several others.

My estimate is that there are between twenty-five and thirty species.

This is the richest fossil coral fauna

* Dall and Stanley-Brown, *Bull. Geol. Soc. Amer.*, Vol. V., 1894. Pp. 151, 152.

known from any one locality of the continental North American Tertiaries. However, the state of preservation of the specimens is not always satisfactory, and it may not be possible specifically to describe all of them.

The particular interest of this fauna does not lie in its richness, but in its geologic import. The Tertiary coral faunas of the United States below the Chipola horizon were very isolated, no species from the continent, excepting the *Orbicella* mentioned, being found in any other area. This fauna is distinctly Antiguan in types. Besides the *Orbicella* referred to, there is a very large-celled *Orbicella*, very close to *O. crassilamellata* (Duncan), if not identical with that species, found abundantly at Russell Spring. An *Astrocœnia* is extremely close to *A. ornata* of Duncan from Antigua. The same remark will apply to the *Stylophora* and *Alveopora*.

From this field examination it appears that the reef corals of the Antiguan marls and cherts can be correlated with the base of the Chattahoochee limestone, the base of Dall's Upper Oligocene. It is also quite probable that the Oligocene reefs in the vicinity of Lares, Porto Rico, and of Serro Colorado, Curaçao, represent the same horizon. The Bowden, Jamaica, fauna would be slightly higher, to be correlated with the Chipola fauna.

It is evident that this coral fauna from Russell Spring, besides filling a gap in the faunal succession on the continent, furnishes a basis for correlating many of the West Indian fossil reefs with the continental Tertiary section, and we may confidently expect more light upon the correlation of American and European horizons.

One interesting feature of these corals, not already mentioned, is that they apparently bring the fauna of Vicksburg, Mississippi, into closer relation with the succeeding faunas. A great deal is shown regarding the succession and interrelations of the faunas of the continent itself.

A fossil coral reef is always interesting, as it reveals in an accurate manner the physical conditions prevailing in a region during a certain portion of its geologic history.

When the material collected has been carefully studied in the office, a detailed account will be published.

T. Wayland Vaughan.

Bainbridge, Ga., Nov. 3, 1900.

PEACH YELLOWS: A CAUSE SUGGESTED.

Some scientific problems lie beyond the reach of present knowledge, in the sense that they are inaccessible through combinations of known facts or methods of research; in dealing with such matters speculation is permitted full sweep in the hope that some hypothesis may point the way to experimental effort and demonstration. There are, however, other questions to which it seems that ascertained facts should furnish a sufficient clue, though the solution may long elude us. With regard to these, speculation appears to have less propriety, perhaps because we have learned to expect more from increased skill and improved methods of research than from theoretical considerations. But if one of these apparently ripe fruits of knowledge refuses to fall, the efforts of the investigating scientists take on added interest, and the bystanders may become anxious to tell just how it should be done. Thus far these well-intentioned people have not been permitted much satisfaction in connection with the mystery of the peach-yellows, the vigorous and sustained attack by the first investigator, Dr. Erwin F. Smith,* having left untried no theory or method which had been applied in previous studies of

* Dr. Smith's results were finally summarized in Farmer's Bulletin No. 17, U. S. Department of Agriculture, 1894.

plant pathology. Results of great economic value were reached, but the cause has still eluded proof or well-founded suspicion.

And yet after the lapse of a decade interest in peach-yellows has increased rather than abated in the minds of those who witnessed and properly appreciated the original researches. It is true that the wish to repeat any of Dr. Smith's comprehensive investigations would scarcely occur to any one who realized the thoroughness of his methods, but in my experience, at least, every new fact or suggestion which seemed in any way likely to furnish an analogy or other clue to peach-yellows has been carefully scrutinized. During the past summer it has seemed to me to be possible to meet the peculiar requirements of the facts by means of a hypothetical cause, and as this is of a nature such that observation and demonstration may be expected to prove difficult and time-consuming, it seems justifiable to place on record the circumstantial evidence drawn from more general biological considerations, in order that those specially concerned with investigations in this line may have any advantage possible from a suggestion which there is no present opportunity to put to a practical test.

Briefly stated, the proposition is simply that the 'yellows' of the peach may be the result of the poisoning of the protoplasm of the living cells by the bite of a small arthropod, probably a mite of the family Phytoptidæ. The fact that plant cells may be so poisoned by mites as to become yellow and yet retain their vitality for many months, or even for years, was impressed upon my attention while observing a palm of the genus *Thrinax*, which had been infested with the so-called 'red-spider' (*Tetranychus*). That this animal was the cause of the injury was inferred from the fact that the formation of yellow spots ceased as soon as it was exterminated from the plant. This was graphically shown in a young leaf which while still folded was attacked on the exposed lateral segments, where the yellow spots are still distinct, though all other parts are entirely untouched and have remained uniformly green. Discoloration spreading thus from the puncture of an insect or a mite is, of course, no new thing, and is often accompanied by much more serious injuries; moreover, we have all the wonderful phenomena of galls as evidence of the power of animal secretions in profoundly modifying vegetable tissues aud structures. The interest of the spots of the *Thrinax* lies merely in the suggestion of a progressive and permanent injury of the tissues without malformation or other striking symptoms. It is true that there is a wide gap between progressive change in a spot less than a quarter of an inch across and one which covers a whole peach tree, but the difference may be one of degree and not of kind, and from the physiological standpoint the galls go far to connect the two extremes. This analogy is especially pointed with the galls induced by inoculation, such as those of the plant-lice and mites, which remain outside the tissues of the host-plant, and yet cause protective malformations.

As the effects of yellows upon the plant tissues could scarcely be thought to be of any advantage to the animal, it may be supposed that no special secretion is involved other than the normal salivary fluid, which might be expected to contain digestive ferments or enzymes,* some of which are now known to exhibit the phenomenon of indefinite self-propagation when brought into contact with substances on which they are capable of acting.

* I am informed by Mr. A. F. Woods that he has for some time entertained an opinion of the enzymotic nature of peach-yellows, drawn from a study of the symptoms of the disease, and from the presence of abnormal quantities of oxydizing enzymes. Cf. *Centralblatt für Bakteriologie, etc.*, 2 Abt., V, p. 574.

Among the important points demonstrated by Dr. Smith, in addition to the absence of any parasitic organism within the tissues, was the communicability of the disease. This fact the present theory amply accommodates, and at the same time does not require insects or mites in large numbers, since the disorder is known to be progressive throughout any tree which has once given evidence of infection. Inoculation by budding from diseased trees also communicates the yellows, a fact which would exclude insect injuries as commonly understood, but which is not inconsistent with the present theory, although the isolation of the deleterious substance or even direct inoculation by the application of the juices and disorganized tissues has thus far failed.*

The presence of an infected tree has been believed to have a distinct effect in inducing the disease in others, though trees will sometimes remain healthy for a considerable period in close proximity or even in contact with those already victims of the malady, and young trees planted in the places of those killed by the yellows are no more liable than others to take the disease. These facts seem peculiarly perverse in connection with a theory of direct infection by a parasitic organism, but become quite comprehensible if the injury be ascribed to mites carried about by bees or by birds; infection would thus be largely accidental, and while the chances would be greater in the neighborhood of diseased trees, no regularity nor continuity in the spread of the disorder need be expected.*

Finally, it was demonstrated by Dr. Smith that neither the character, condition or relative fertility of the soil, nor the age, vigor or variety of the tree has any appreciable influence in predisposing to attack or in securing immunity. Such facts are evidently ample for the exclusion of any hypothesis based on the predication of a constitutional disorder originating independently in the tissues of the trees. The implications point uniformly in the contrary direction, to a definite cause in the form of a specific noxious substance the application of which is followed by a uniform bio-chemical reaction. This inference is not weakened by the fact that the reaction is slow, and that the results of infection become apparent only in new growth from buds or tissues which have been reached by the disease. Thus the first definite symptom of debility caused by infections which may be supposed to have taken place in the spring appears in the premature ripening of the fruits. It has also been noted by Dr. Smith that the degree of prematureness is extremely variable, a fact which seems ex-

* Dr. Smith tells me that *Phytopti* were frequently found by him on yellowed peach trees, and that while the idea that they might cause the disease in the usual manner of parasitic insects suggested itself early in the course of his studies, he rejected it because entirely inadequate to explain the extensive constitutional symptoms which led him to compare the yellows to hydrophobia and smallpox, other communicable diseases of which the causes have resisted investigation. It is trne also that the infection phenomena of these diseases appear to include the necessity of inoculating or poisoning cells which remain alive, and from which the disease may be propagated by protoplasmic continuity. Bacteria, on the contrary, are able to pass from one plant cell to another only by breaking down the cell-walls, though the disorganizing effects of their chemical products may precede them.

* The presence of bird's nests may prove to be connected with the not infrequent occurrence of several apparently simultaneous infections in the same immediate vicinity, though not necessarily on contiguous trees. If brought in by small birds it is easy to see that the chances of forming a colony of the injurious mites are many times greater on a tree where a nest is placed, and where the birds spend a large part of their time during the breeding season. Moreover, the well-known persistence of the migratory birds in returning to the same nesting-place would tend to insure a rapid dissemination of the yellows in the year after a colony of the mites had been established in the orchard.

plainable by possible differences in the dates of infection and in the distances through which the disease must propagate itself before it reaches the growing fruit, the normal development of which is inhibited, although the tissues previously formed remain apparently uninjured. The suggestive phenomena of the palm are also capable of a similar explanation, the susceptibility to spotting being apparently confined to the young leaves; otherwise it is difficult to understand why the entire area of the older leaves had not turned yellow long since. The same is likewise true of the leaf-spot or stigmonose of carnations, investigated by Mr. A. F. Woods.*

It can scarcely be expected that many cases completely parallel to the yellows will be found in nature, since parasites which produce such disastrous effects upon their hosts must be unable to maintain extended existence. It is accordingly not to be supposed that the peach is the natural or exclusive habitat of an insect or mite which is able to produce such a disease as peach-yellows. In the biology of galls the localization of the irritant or pathological effect is essential to the establishment of a successful and permanent symbiotic relation, although the possibilities of extensive change through animal irritants are amply shown in the general debility evident in some plants when parasitized by gall-forming insects. These considerations are of special interest in connection with a fact which is of use at least as an analogy, and which may possibly furnish a direct clue to the mystery, since on other plants both galls and hexenbesens have been connected with species of the same group of mites. In a disease of plum nursery-stock reported by Mr. M. B. Waite, one of the prominent symptoms of peach-yellows, the fasciculate branching or hexenbesen formation, was found to be caused by a minute parasitic mite (*Phytoptus?*). In this instance the terminal bud is killed, while the lateral buds in the neighborhood are pushed into premature growth. That this latter development is not caused simply by the death of the terminal bud, but is stimulated by the presence of a noxious compound, is probable, though the disorder is not progressive in the plum, and the removal of the malformed branches permits the resumption of normal growth. The suspicion that the active cause may be similar, if not the same as that of the yellows, is considerably strengthened by the fact that the yellows, while recorded as occurring in almonds, apricots, nectarines and Japanese plums, is not known to affect other sorts of plums. With the supposition of such identity of cause we arrive at the proposition that the mite elaborates in its salivary or other glands an enzyme or other active compound to which the tissues of the peach and closely related fruits are peculiarly susceptible, and which produces in them a permanent and ultimately fatal debility accompanied by definite constitutional symptoms. And that this susceptibility depends on some delicate relation of structure or composition is shown by the fact that the Japanese plums are affected, while the European and American cultivated species appear to stand on the plane of at least partial immunity, being able to resist and recover from the infection. It would thus be possible to accommodate all the related facts in the construction of a complete analogy with the known limitations of many other diseases to groups of related varieties and species.*

* Bulletin No. 19, Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, 1900. This disease was formerly ascribed to bacteria, but is here shown to be due to the punctures of aphides.

* The force of this analogy is rather strengthened, although its terms may need to be altered, by a fact verbally communicated by Mr. Waite, that a similar dis-

The only novel proposition employed in this hypothetical solution of the problem is that of the indefinite propagation of the pathological effects of a toxic compound of animal origin, introduced in an infinitesimal quantity and of so mild a physiological action as to cause no immediately appreciable damage. And yet the fact of inoculation shows that this requirement must be admitted as far as the internal phenomena are concerned, whatever be the supposed nature of the exciting cause. As already pointed out by Dr. Smith, this phase of the subject has analogy with other abnormal conditions such as variegation of foliage, which in some plants may also be propagated by grafting. But albinism may easily prove to be a composite phenomenon, sometimes constitutional and sometimes induced, and then transmissible. That the albinism theory of peach-yellows is not, however, necessarily inconsistent with that of its origin through mites is indicated by a curious fact for which I am indebted to Mr. H. J. Webber. An albinistic variety of orange, 'Drake's Star,' was found in Florida to be entirely immune to the orange-rust, caused by one of the Phytoptidæ. As albinism, or variegation, is generally admitted to be connected with or accompanied by a lack of vigor, there is the greater warrant for expecting that the present instance of immunity will not prove to be due to any ability to resist the attacks of the mites, but will be found explainable by the absence from the albinistic protoplasm of the compounds affected by the secretions of the *Phytopti*. A definite relation of incompatibility having been established between an albinistic condition and a disease caused by *Phytoptus*, and involving a yellow discoloration of the cells, the physiological analogy between yellows and albinism is strengthened, and the anomalous proposition of an animal poison causing a constitutional plant disease transmissible by budding loses something of its apparent improbability. Further possibilities not unworthy of mention lie in the production of immunity in the peach through inoculation with a less harmful mite, or with a modified enzyme or antitoxine, or with a mild form of albinism, or through the propagation of albinistic varieties. The uniform susceptibility of the sorts now in cultivation in the infested districts renders it extremely improbable that a normal variety able to resist the yellows could be secured by selection or introduction from abroad.

A further biological reason for belief in a definite external cause for peach-yellows is to be found in what may well be considered a second species of the same genus, the so-called 'peach-rosette,' which has appeared in the orchards of Georgia and as far west as Kansas. This disorder is of a much more virulent type than the yellows, and is able to attack and destroy the plum. It has distinctly different, though similar, symptoms and is likewise contagious and communicable by budding. With two such diseases occupying reasonable definite geographic areas and both repeatedly occurring sporadically within wide general limits, the probability is greatly increased that we are dealing with the injuries of two species of *Phytoptus* or related mites which are normally parasitic on native vegetation, probably indigenous species of *Prunus*, whence they are accidentally transferred to the peach and related fruits of foreign origin, supposably by bees or by birds. Such a method would explain the many independent reappearances of the diseases, and their capricious distribution in orchards, where contiguity or even contact

order of peach nursery stock has also been traced to a mite, even though it may be found that the animal is of a species different from that of the yellows. Neither can we as yet exclude the possibility that the peach may be less susceptible when young than after it has reached bearing age.

has sometimes been found to have little or no effect in facilitating transmission. The facts which have been taken to indicate a gradual spread of the diseases, and thus have been used as an argument for an epidemic type of infection, are as well or even better provided for in the above suggestion, if proper allowance be made for the fact that such diseases are brought to the attention of pathologists only when they threaten serious damage to commercial interests in the hands of intelligent horticulturists. This would be by no means the first instance where the extension of our knowledge of a disease has been interpreted as an extension of the disease itself. As with most other plant diseases, neither the yellows nor the rosette was recognized as a definite malady until an organized industry was attacked. Both were at first supposed to be local, and though a wide distribution has been ascertained, there is nothing to indicate that either was introduced from Europe or has spread to California, facts which also militate strongly against theories of the constitutional origin of the diseases, though possibly comparable with the failure of the above-mentioned orange-rust mites to establish themselves in the dry atmosphere of California.

That the yellows has not gone south and that the rosette has not come north are also indications that the diseases are not spread entirely from the peach, if we admit that both disorders had probably existed for many decades before their scientific recognition. In fact, the various considerations of distribution are sufficient to warrant a belief in local origin and external infection, and it is not even necessary to insist that they are transferred in nature from one peach tree to another, since the existence of the injurious species in the neighborhood of an orchard would mean that infection might be indefinitely repeated. It is also to be remembered that under the theory of infection of an entire tree by a single puncture it is to be expected that there will be many trees with yellows where none of the injurious mites can be found, since only when fertilized females or both sexes are transferred will the species be multiplied. Thus might the yellows be 'contagious' from some trees, where colonies are formed, while not contagious from others.

But though the mite should be found to breed upon the peach, insecticides would remain useless, since the infected trees are injured beyond repair and may as well be removed and burned, as Dr. Smith has urged. That this policy has appeared to keep the yellows in check in some parts of Michigan may mean that either our supposititious mite or the agent of its transfer to the peach is locally rare. We have, in fact, all gradations from an apparent epidemic in some parts of the East to a merely sporadic condition in Illinois, where competent investigators are not yet convinced that the disease is contagious.

It is a fact well known to entomologists that the numbers of many species of insects and other short-lived arthropoda vary enormously in different years or periods of years. An unfavorable season, an active enemy, or a disease may reduce a species to practical non-existence for a time, until the return of favorable conditions permits a gradual increase to the former numbers, or even to unrecorded abundance. These fluctuations are also closely comparable with those which appear in connection with parasitic fungi and bacteria, species previously so rare as to have remained quite unknown to the botanist often appearing suddenly as the agents of extensive injury. Seasonal and periodic as well as local differences in the apparent 'virulence' of peach-yellows would thus be readily explainable on the present theory, to which plant pathologists need not object because of reasons drawn from the history of the malady.

A permanent solution of the problem on these lines may be postponed by the fact that, notwithstanding their well-known economic importance, the Phytoptidæ remain a little-known group, even from the systematic standpoint, doubtless owing to their excessively small size. But if the present hypothesis should prove to have any basis in fact, it will probably be possible to control or even to exterminate the yellows by the local destruction of the wild relatives of the peach which may be found to harbor the offending creatures. The extent to which this would be necessary for the protection of peach-orchards will depend upon the agency of transmission. Fortunately the mites are without wings, and whether carried by small birds or by insects, the distances whence they would ordinarily be brought are not great. There is thus opened another possibility, at least, of the relief of this important industry from the ravages of maladies which not only cause thousands of dollars of damage annually, but which are chargeable with a further public injury in limiting the production and popular enjoyment of this finest of temperate fruits.

O. F. COOK.

WASHINGTON, D. C.

SCIENTIFIC BOOKS.

Leçons de chimie physique. Professées a l'Université de Berlin. Par J. H. VAN'T HOFF, membre de l'Académie des Sciences de Berlin. Professeur ordinaire a l'Université, et directeur de l'Institut de Physique de Charlottenbourg. Ouvrage traduit de l'allemand par M. COEVISY, Professeur agrégé au Lycée de Saint-Omer. Paris, Librairie Scientifique, A. Hermann. 1899.

The book in hand is a French translation of Van't Hoff's lectures on 'Selected Chapters in Physical Chemistry' which he now delivers at the University of Berlin. As the title implies, the book is not a systematic treatise on the whole subject of physical chemistry, but the number and importance of the subjects dealt with are so great that the scope of the work is not small.

The order of arrangement is quite different from that usually adopted. It is the general custom to take up first the older work in physical chemistry which has to do with the relations between composition and physical properties, and constitution and physical properties. This is then followed by the newer physical chemistry, dealing with solutions and energy transformations in the broad sense; concluding with chapters on chemical dynamics and chemical statics.

Van't Hoff has, indeed, exactly reversed this order. Part first is on Chemical Dynamics, including chemical equilibrium and reaction velocity. Part second, on Chemical Statics, contains chapters on molecular weights, molecular structure and molecular grouping; and it is not until the third and last part of the book is reached that we find a discussion of the relations between properties and composition; comprising relations between physical properties and composition on the one hand, and chemical properties and composition on the other.

In those who have been accustomed to the older order of things this new order of presentation produces a little discord. This, however, may not argue against the method adopted by Van't Hoff. It should, nevertheless, be noted in this connection that the more generally accepted order of presentation is far more closely in accord with the historical development of the subject, and there are those who believe in the pedagogical value, at least, of the historical method.

The newest work of Van't Hoff, like everything which he has written, is full of original and brilliant suggestions. There is hardly a subject touched, in the whole book, without new light being thrown upon it and new relations pointed out. No one can read the work without feeling that physical chemistry is here treated by a master hand, which not so much compiles as creates.

These lectures are, for the most part, rather advanced, as we should naturally expect them to be. They should, therefore, not be placed in the hands of a beginner. To any one who has mastered the elements of physical chemistry this book is indispensable, and it should be read by all who desire to keep abreast with the newest and best which has appeared in the field of general chemistry.

H. C. J.

Determination of Radicles in Carbon Compounds. By Dr. H. Meyer, Docent and Adjunct of the Imperial and Royal German University, Prague. Authorized translation by J. Bishop Tingle, Ph.D., F.C.S., Instructor of Chemistry at the Lewis Institute, Chicago, Ill. New York, John Wiley & Sons; London, Chapman and Hall. 1899.

This English edition of Dr. H. Meyer's 'Anleitung zur quantitativen Bestimmung der organischen Atomgruppen' will be heartily welcomed by all teachers and advanced students in organic chemistry. As the translator well says in his preface: 'The quantitative side of organic chemistry, apart from elementary analysis, is almost always neglected in the ordinary courses of instruction, and when the need for it arises, in the prosecution of research work, for instance, it is difficult to obtain a comprehensive view of the methods which are available without undue expenditure of time.' The present work supplies a systematic treatment of the various methods in use for determining quantitatively most of the groups ordinarily found in carbon compounds in a very convenient and compact form. It is to be hoped that it will bring about the introduction of some quantitative work into the regular college course of organic preparations. Some idea of the character of the book may be given by the following brief synopsis of its contents. The book is divided into five chapters. Chapter I., which is introductory, treats of the determination of hydroxyl (—OH); Chapter II. of methoxyl (CH_3O—), ethoxyl (C_2H_5O—), and carboxyl (—COOH); Chapter III. of carbonyl; Chapter IV. of the amino and related groups and Chapter V. of the diazo-, hydrazide-, nitro-, iodoso- and iodoxy-, and the peroxide-groups. The author has made various corrections and additions to the English edition, so that it is an improvement on the German one. The book is well printed and bound in convenient form for laboratory use. It has a good index of both subjects and authors' names, and an appendix containing some useful tables. The book can be most heartily recommended to all organic chemists.

W. R. Orndorff.

SCIENTIFIC JOURNALS AND ARTICLES.

In *The American Journal of Physiology* for November, J. C. Herrick reports an investigation of the influence of temperature on nervous conductivity. He found that a strong or moderate action current produced by an induction current or condenser discharge was not changed in intensity when the nerve impulse passed through areas varying in temperature from 8° C. to 40° C. Usually a decrease in current followed the application of temperature beyond these limits. An increase in the strength of action current in passing the impulse through a warmer area occurs, however, under two conditions—when the action current is only a small fraction of the maximum, and when the entire nerve except the warmed part is below 10° C. From his observations he concludes that the action current ordinarily observed and studied probably lies far beyond those accompanying maximal functional impulses.

Porter and Muhlberg present an experimental criticism of the theory that injury produces prolonged inhibition of the activities of the spinal cord. Believers in automatism of the cord have explained the failure of the cord to continue orderly functioning after separation from the brain, by assuming that the conditions of experimentation inhibit the spinal centers for a long period. To settle the question, the cell bodies of the respiratory nerve of the diaphragm were separated on one side of the spinal cord from the respiratory center in the brain. After this was done, these cells were still able to discharge motor impulses, but their apparently automatic rhythmic respiratory power was gone. Animals kept for a long period after this operation proved that the loss was permanent, and that it could not, therefore, be ascribed to inhibition.

Artificial division of egg cells, now attracting so much attention, has been further investigated by A. P. Mathews, who presents the results of observations on Arbacia eggs. Mathews found that karyokinetic nuclear division followed by cell division may be produced by lack of oxygen, by heat and by exposure to ether, alcohol and chloroform. Since all the methods which induced karyokinesis in these eggs are well-known methods of causing liquefaction in protoplasm, Mathews suggests that the essential basis of karyokinetic cell division is the production of localized areas of liquefaction in the protoplasm.

S. I. Franz's paper, 'On the methods of estimating the force of voluntary muscular contractions and on fatigue,' is largely a destructive critique of the methods hitherto employed for determining muscular ability. With a weight ergograph or with an ordinary spring ergometer two variables are always present—the force and the extent of a contraction. These two factors are so variable in different individuals that accurate comparison of relative muscular ability is impossible. A third variable in the use of these instruments is noted in the nutrition changes of the working muscle. The isometric use of a spring is recommended because the main factor in an investigation of fatigue—muscular force—is practically isolated. The results of fatigue experiments show that after 150 maximum contractions the muscle can accomplish about 40 per cent. as much as it could at the beginning of the series. A large daily variation in results is noted. This factor, which has been almost wholly neglected in previous researches, indicates that the conclusions of early investigators should be held only until they can be investigated further.

THE *American Journal of Insanity* for June, in addition to the articles noted in our last issue, contains a paper by Dr. F. Savary Pearce, of Philadelphia, who presents 'Further Laboratory Studies on Uric Acid in Neuræsthenia and on Auto-intoxication in Nervous Disease,' in which he says: "We have sufficient data to say positively that neuræsthenic conditions are associated with the circulation of such an irritant in the blood. From the observations of Haig, it seems clearly proved also that when the uric-acid elimination is decreased, the urea elimination is normally increased. The amount of elimination of urea is in proportion to the albuminous food products properly absorbed into the blood, thus giving rise to strength and a feeling of latent vigor in the system so nourished. On the other hand, there assuredly follow a sense of feebleness and lack of resistance when the uric-acid elimination goes above the normal and, in consequence, the urea elimination falls. In 'Degeneracy' Dr. O. Everts, of Cincinnati, calls attention to the fact that the term degeneracy is without uniformity of meaning or restricted definition. He regards degenerates as "all persons who by reason of mental deficiency are incapable of self-support, as well as those who by reason of mental deficiency are incapable of perceiving the sinfulness of sin or the beneficence of restraint therefrom." He believes degeneracy to be an inevitable sequence of civilization without any hope of remedy. Dr. W. L. Worcester, of Danvers, Massachusetts, presents 'Three Cases of General Paralysis in Young Women' together with the pathological findings at the autopsies. One of these cases was a young mulatto. Dr. Charles E. Woodruff, of the U. S. Army Medical Corps, has a paper entitled 'Degenerates in the Army.' He finds that few of these degenerates in the army present the characteristic stigmata of degeneration, a fact which he believes to be due to the rigid examination to which all recruits are subjected upon enlistment. Degenerates in the army come from the borderland of partial degeneracy, the criminaloids of Lombroso. Some are cases of slow development—partial infantilism—who have run away from home in search of adventure, but more are mild types of the neuræsthenic tramp, restless, unstable and flitting from one employment to another. They are unable to endure monotony of army life with its rigid discipline and are generally deserters.

The Journal of Comparative Neurology for October contains the following articles: 'A Contribution upon the Cranial Nerves of the Cod Fish,' by C. Judson Herrick, with 2 plates; 'Notes on Professor Judson Herrick's Paper on the Cranial Nerves of the Cod Fish,' by F. J. Cole; 'Further Observations on the Conditions determining the Number and Arrangement of the Fibers forming the Spinal Nerves of the

Frog (*Rana virescens*),' by Irving Hardesty. 'Anastomosis of Nerve Cells in the Central Nervous System of Vertebrates,' by N. Worth Brown, with plate; 'A brief Summary of the Researches of Theodere Kaes on the Medullation of the Intra-cortical Fibers of Man at different Ages,' by Helen Bradford Thompson; 'Book Notices.'

THE *Botanical Gazette* for November contains an important paper, by Burton E. Livingston, of the University of Chicago, on the nature of the stimulus which causes the change of form in polymorphic green algæ. The form used was a species of *Stigeoclonium*, and it was made to assume the spherical or filamentous form and to organize zoospores or not at will. The evidence seems perfectly clear that the responses, both in form and reproductive activity, are due to changes in the osmotic pressure of the medium and are in no way functions of its chemical composition. A high osmotic pressure decreases vegetative activity, inhibits the production of zoospores, causes cylindrical cells to become spherical, and frees the alga from certain limitations as to the orientation of planes of cell division, while a low pressure has the diametrically opposite effect in each case. Professor Conway MacMillan publishes some careful observations upon the structure of *Lessonia*, one of the huge Laminaria forms. The material studied was cast up upon the beach of Vancouver Island. Mr. C. D. Beadle, of the Biltmore Herbarium, describes ten new species of *Cratægus*. Mr. John F. Cowell, Director of the Buffalo Botanic Garden, gives an appreciative biographical sketch, with portrait, of the late David F. Day. Mr. Carleton E. Preston, of Harvard University, records some field observations as to the root system and vegetative propagation of Cactaceæ.

Popular Astronomy for December has for a frontispiece the New Allegheny Observatory, whose corner stone was recently laid. The address delivered upon this occasion by J. A. Brashear is given in full, as well as notes descriptive of the corner stone exercises and the building itself. Another topic of interest to general readers is that of the *Leonid Meteors* watched for last year and this. Professor W. W. Payne discusses their orbit, and the results of the observations made at various points this year are noted and charted. Kurt Laves' practical help on the 'Adjustment of the Equatorial Telescope' is continued in this number, and Charles P. Howard's paper on the 'Total Eclipse, of May 28, 1900,' is begun. E. S. Holden writes, 'Among the Stars,' and S. W. Burnham contributes two short articles on double stars. Many brief reports of the Eros observation work are included in the general notes, which, with the usual Spectroscopic, Planet, Comet, Asteroid notes, completes the last number of the volume for 1900.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 104th regular meeting was held at the Cosmos Club, November 14, 1900.

The following papers were presented:

'Notes on Lake Chelan and Vicinity,' by Mr. Bailey Willis.

The Cascade Mountains of Washington State constitute a plateau, so thoroughly dissected, however, that none of the original surface remains. The greater number of the resulting sharp peaks and ridges have summits close to an imaginary sloping plane ranging in altitude from 3,000 to 8,000 feet. The initial uplift was succeeded by development of moderate relief, followed by the last and principal elevation. It is not yet known whether this final uplift is late Pliocene or early Pleistocene. Lake Chelan lies in an area of metamorphic and igneous rocks, the oldest of which are schists of sedimentary origin. They are cut by younger granitic rocks. These in turn are traversed by dikes of andesite, diorite porphyry, and acid quartzose porphyries.

'Remarks on Troost's Geological Map of the Environs of Philadelphia, 1826,' by Mr. G. P. Merrill.

A copy of this rare map, which the Marcous, in their catalogue of geological maps of North America, state is unknown, was exhibited to the Society.

'Ore Deposits at Monte Cristo, Washington,' by Mr. J. E. Spurr. Among the rocks of the Monte Cristo district are arkoses and quartzites, and a variety of volcanic rocks, comprising andesites, rhyolites, dacites and basalts. There were two periods of andesitic eruption. The arkoses and the older andesites which are among the most ancient rocks, are cut by large dikes of tonalite, which have altered the intruded rocks near the contact to quartz, biotite, garnet and staurolite schists. Strong, steeply dipping, jointing or sheeting is one of the latest geologic structures, and accepting the principal uplift of the range as late Pliocene, the jointing is probably not older. Along these joints most of the ore deposits have formed. The ores consist chiefly of arsenopyrite, chalcopyrite, phyrrhotite, pyrite, blende, galena and some less important sulphides. The deposits occur mainly in the tonalite and to a less extent in the older andesites, occasionally in the other rocks.

'The Mother Lode, folio, California,' by Mr. F. L. Ransome.

This special mining folio No. 63 of the Geologic Atlas of the United States was shown and its scope briefly outlined. It deals with an area six and a half miles wide and seventy miles long, embracing the greater portion of the so-called 'Mother Lode' system of gold-quartz veins.

'Paleobotanical Aspects of Some Upper Paleozoic Formations of Nova Scotia,' by Mr. David White.

A brief *résumé* of the correlations by stratigraphy on the one hand with the correlations by paleontology on the other hand. The Horton and the Riversdale plant beds, which are referred by the Nova Scotia geologists to the Hamilton, are, on the evidence of the fossil plants, referable to two stages; the Horton being Pocono and in the basal portion of the lawn Carboniferous, while the Riversdale plants indicate a stage for these at or near that of the Pottsville.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF BIOLOGY.

THE regular monthly meeting November was held on the evening of November 12th, Professor C. L. Bristol, presiding.

The following program was offered:

F. C. Waite, 'The Bermuda Toad' (to be published in full in SCIENCE).

H. F. Osborn, 'The Phylogeny of the Rhinoceroses of Europe.'

H. L. Clark, 'Further Notes on Bermuda Echinoderms.'

Professor Osborn reported a continuation of his investigations upon the 'Phylogeny of the Rhinoceroses of Europe.' These animals appear to fall under the law of early divergence, and to constitute at least six separate series or phyla, which, so far as known at present, are not genetically related to each other, but undergo a more or less parallel development, as follows: Diceratheriinæ, Aceratheriinæ, Brachypodinæ, Ceratorhinæ, Atelodinæ, Rhinocerotinæ. The chief criteria in distinguishing rhinoceroses are the proportions of the skull, whether dolichocephalic or brachycephalic, the proportions of the limbs in reference to cursorial or aquatic habits, and the position of the horns; subsidiary to these features are the types of tooth structure. The origin of the Rhinoceroses is still obscure, although it appears to be possible to derive the Diceratheriinæ from certain Eocene Hydracodontidæ.

This study will be published in full in the *Bulletin* of the American Museum of Natural History, and it constitutes a part of the continuation of the author's memoir on the extinct Rhinoceroses.

Mr. H. L. Clark's paper was read by Professor C. L. Bristol. In this paper Mr. Clark gave an account of the Echinoderms collected by the party of zoologists from the New York University in the summer of 1899, together with a summary of his own observations during April of that year. It is to be concluded from an abundance of observations that the distinctions hitherto thought to exist between *Stichopus diaboli* and *acanthomela* are not to be regarded as valid, and the forms described under these names must be referred to *S. Möbii*. Twenty-nine species are listed.

Mr. Waite called attention to the fact that the madreporic body in *Asterias tenuispina* branches, forming 1–4 bodies in each animal, thereby making orientation difficult.

F. E. LLOYD, *Secretary.*

TORREY BOTANICAL CLUB.

At the meeting of the Club on October 31st, Dr. P. A. Rydberg read a paper on 'The Melanthaceæ of the Rocky Mountains.' Numerous herbarium specimens were exhibited, including the types of seven new species described by Dr. Rydberg in the *Torrey Bulletin* for October. To these descriptions he now added further particulars regarding habit, distribution and critical characters, presenting also a series of comparative drawings of their petals and sepals. One of these new species of especial interest is *Veratrum speciosum*, to which most of the specimens previously ascribed in herbaria to *V. Californicum* prove to belong. The presence of conspicuous petioles at the lower leaves of typical *V. Californicum* was demonstrated from the type-specimen and also by explicit accompanying statements by Dr. Asa Gray, whose manuscript description was produced.

Edward S. Burgess,
Secretary.

ZOOLOGICAL JOURNAL CLUB OF THE UNIVERSITY OF MICHIGAN.

The first meeting of the club was held November 1st. Dr. S. J. Holmes reported the results of work done at Woods Holl during the past summer on the habits and natural history of *Amphithoe longimana* Smith. The observations made were upon the movements of the animal, food, nest-building and instincts associated with living in nests, moulting, color changes, the seat of smell and the instincts of the young.

Mr. L. J. Cole gave an account of work done at Woods Holl during the past summer on the habits of *Pycnogonids*. Most of the notes were based on observations of *Anoplodactylus*, though *Tanystylum* and *Pallene* were studied also.

Crawling and Swimming Movements.—The action of the legs in crawling and in swimming was analyzed and was found to be exactly the same in the two cases. When the stroke of the legs is strong enough to lift the animal from the bottom, swimming results; otherwise the same movement produces crawling along the bottom. The stroke of all the legs is the same except that it is stronger in the anterior legs, and this is what carries the animal forward in crawling, rather than backward. The action of the posterior legs is an actual hindrance in crawling.

Reactions to Light.—1. Both *Anoplodactylus* and *Pallene* show strong positive phototaxis. In going towards the source of light *Anoplodactylus* may either crawl or swim, being oriented differently in the two cases:

2. In crawling towards the light the animal progresses forward. If not oriented in this direction at first it becomes so oriented by making a short circle in every case towards the light.

3. When an animal walks in a circle those legs on the outside must make a more effective stroke than those on the inside, which means in this case that *those legs away from the light beat stronger than those towards the light.*

4. In swimming towards the light the animal progresses approximately *backward* with the anterior end somewhat raised, the amount depending upon the activity of the individual and the slant of the rays of light.

5. This orientation is brought about by the actions previously mentioned: (*a*) The stronger action of the legs on the side away from the light raises that side, and the animal consequently travels toward the light; (*b*) The stronger action of the anterior legs, as compared with that of the posterior, tends to bring the anterior end of the animal into the upper position, giving the orientation described.

Transfer of the Eggs from the female to the ovigerous legs of the male.—When first observed the male was clinging to the dorsal surface of the female and headed in the same direction. The basal joints of the legs of the female were approximated below with a mass of eggs between. The male crawled around over the anterior end of the female, coming into such a position that their ventral surfaces were together and their heads in opposite directions. The ovigerous legs of the male hooked into the mass of eggs, and as the animals separated carried them away. Fertilization presumably took place at the same time.

At the second meeting, November 8th, Dr. S. J. Holmes presented an account of work done during the past summer at Woods Holl on Phototaxis in Amphipods.

Most of the experiments were performed on two species of Orchestidæ found at Woods Holl, Mass., *Talorchestia longicornis* and *Orchestia agilis*. *Talorchestia* was found to be positively phototactic at all times both in strong and in weak light. *Orchestia agilis* is somewhat less strongly positive since, for a short time after it is taken from the dark, it becomes negatively phototactic, but exposure to the light soon makes all the individuals strongly positive and they remain so even in direct sunlight. Both these species when exposed to direct sunlight remain positively phototactic until overcome by the heat of the sun. Yet the animals when they come to rest are found in shaded spots and, during the daytime, remain unexposed to the light; they are photophobic, but positively phototactic. Observations were made on twenty-two species of aquatic amphipods, all of which were found to be negatively phototactic. It was found that when the terrestrial *Orchestia agilis* were thrown into sea water their phototaxis immediately changed from positive to negative; when taken out of the water the reverse change occurs, and this change was shown to be independent of temperature.

Orchestia agilis, when brought from strong light, in which it is strongly positive, to weak light, immediately becomes strongly negative, a result which, it is believed, has been observed in no other form. When left in weak light the negative phototaxis disappears and all the specimens become positive again. This result was shown to be independent of temperature. Specimens rendered negative by being brought into a dimly lighted room after exposure to strong light become positive more quickly if the temperature is raised. Exposure to darkness or to very strong light renders *Orchestia agilis* temporarily negative in light of medium intensity.

In *Talorchestia*, *Orchestia*, and several species of insects that are positively phototactic it was found that, when one eye is blackened over, the animal travels in circles with the unblackened eye looking towards the center. In several negatively phototactic forms blackening one eye was found to produce circus movements in the other direction, the unblackened eye looking away from the center. *Orchestia agilis* may be caused to execute circus movements in the one or the other direction according to whether it is placed in air or water.

H. S. JENNINGS,
Secretary.

DISCUSSION AND CORRESPONDENCE.

THE ELECTRICAL THEORY OF GRAVITATION.

PROFESSOR FESSENDEN in a recent number of SCIENCE discusses the nature and velocity of gravitation. There is, no doubt, something of value in Professor Fessenden's suggestions and much that is new. However, the explanation of gravitation which Professor Fessenden offers is by no means so adequate as would appear from Professor Fessenden's discussion.

In the first place, *Quantitative Mathematics*, as Professor Fessenden styles his papers on Dimensions, has little or nothing to do with the thing. The present writer makes this statement not entirely as an expression of his own opinion, but quite as much as an expression of opinion of every physicist with whom he has talked on the matter. Professor Fessenden claims to have derived *numerical functional relations*, with the aid of his 'Qualitative Mathematics,' and this is believed on definite rational grounds by most physicists to be impossible.

One of the best examples of the application of 'Qualitative Mathematics' is its application by Lord Rayleigh (*Philosophical Magazine*, October, 1899), in his 'Investigation on Capillarity.' In this instance the weight of a drop of water falling from the end of a glass tube is shown to be a certain function of radius of tube, density of water, acceleration of gravity and surface tension of water *multiplied by an unknown function of these quantities having zero dimensions in length, mass and time.* This unknown and unknowable function—to be determiued by experiment only—Fessenden seems to lose sight of in his 'Qualitative Mathematics.' The reader who wishes to get the gist of Professor Fessenden's suggestions as to the nature of Gravity may therefore, as it seems to us, ignore what he says of, and is led to say by 'Qualitative Mathematics.'

The following is a brief and fairly simple outline of the electrical hypotheses which are now held by physicists in the attempt to explain the ultimate constitution of matter and the nature of inertia and of gravitation.

Electrically charged bodies are of two kinds, namely, positive and negative. Like charges repel and unlike charges attract. The energy associated with two charged bodies is seated in the ether which surrounds the two bodies and is due to the electrical field or ether stress. When *unlike* charges approach, the energy of the ether stress diminishes and the outside work done by the attraction of the charges is equal to the diminution of the energy of the ether stress. Similarly, the energy of ether stress, which is associated with two *like* charges, increases when the charges are pushed towards each other and the increase of the energy of the ether stress is equal to the work done in pushing the two charges nearer together.

In general, attraction of two bodies is to be attributed to ether energy, which *decreases* as the bodies approach each other, and repulsion of two bodies is to be attributed to ether energy, which *increases* as the bodies are made to approach each other. Physicists have known this many years and, as regards gravitation, no satisfactory clue has yet been found concerning the nature of the accompanying ether energy and concerning its mode of propagation from place to place.

It is now pretty well established, that the ether energy having to do with electrical attraction and repulsion is dependent upon a sort of *shearing distortion* of the ether unaccompanied by any sensible diminution of volume, that this ether distortion is what is known as *electric field*, that the propagation of this energy constitutes *electrical waves*, and that the movement of the ether which comes into play during the establishment of this shearing distortion, or which comes into play while distortion at one place is relieved and distortion at a contiguous place is built up, is what is known as *magnetic field*.

It may be that the ether distortion which we call electrical field is accompanied by a very slight diminution of volume of the ether, especially inasmuch as Maxwell showed that the mechanical stresses in the dielectric tend to produce diminution of volume as well as to produce shearing distortion. These mechanical stresses are proportional to the square of the field intensity at each point.

If we admit that the diminution of volume of the ether at each point is proportional to the resultant intensity of the electric field, then the part of the energy which depends upon diminution of volume cannot be separated in its effects from the part of the energy which depends upon the shearing distortion, inasmuch as both are proportional to the square of the resultant field intensity. Therefore a diminution of volume of the ether could not explain gravitation, but would only be involved in the explanation of ordinary electric attraction and repulsion. Professor Fessenden in his article above referred to speaks quite in general of the compression of the ether near a charged body (or ion) without localizing this distortion.

Before proceeding to a statement of what must constitute the characteristic features of an explanation of gravitation, as opposed to an explanation of electric attraction and repulsion, for the reader will certainly think of an explanation of the one as applying satisfactorily to the other also, so far as the above discussion goes, it is necessary to outline briefly the present hypothesis that the inertia of an atom, or rather that the inertia of a corpuscle, is due to its electric charge.

It has been known for some years that a moving electrically charged body has more kinetic energy for a given velocity than if it were not charged; that is, the acceleration of a charged body by a given force is less than if the body were not charged; that is, the inertia of a charged body is greater than if it were not charged. This excess of energy of a moving, charged body—for the whole matter lies in the question of energy—is due to two things, as follows:

First, The dying away of the electric field in regions passed through by the body and the building up of electric field in regions newly reached by the body is accompanied by an ether motion known as magnetic field, as above stated, and this magnetic field represents energy.

Second, The motion of a charged body tends to concentrate the electrical field or ether stress in and about a plane passing through the body and at right angles to the direction in which the body is moving. This concentration of the electric field causes, on the whole, an increase in the total energy of the electric field.

A curious fact, assuming the truth of the following hypothesis, is that the energy of a moving body is *not* proportional to the square of its velocity, but exceeds this by an amount which becomes infinite when the body attains the velocity of light, although this excess of energy at ordinary velocities is exceedingly small. If it were not for the tendency of electrical field to become concentrated in a certain plane as described above, the energy of a moving body would be strictly proportional to the square of the velocity, assuming the truth of the hypothesis which is now to be stated.

The excess inertia due to the electric charge on a body, or briefly, the inertia of the charge is greater and greater the smaller the body. Atoms, however, are not small enough for us to attribute *all* their inertia to the charge which they carry when they are in the form of ions. The corpuscles, of which J. J. Thomson builds an atom like a bricklayer builds a house, and to the hypothetical existence of which Thomson was led by the study of cathode rays, are perhaps small enough.

The electrical hypothesis of the constitution of matter, is that atoms of matter are built up of corpuscles, and that these corpuscles are mere bits of electric charge, some positive and some negative surrounded by electric fields, or rather that these corpuscles are mere strain ceuters in the ether surrounded by regions of ether stress.

This hypothesis of the coustitution of matter serves well for the interpretation of the perplexing class of phenomena attending the discharge of electricity through gases and it explains that fundamental property of matter, inertia.

Now we have two distinct measures of mass, namely: One body is said to be twice as massive as another, or to contain twice as much matter, when it is *accelerated* at half as great a rate by the same force or when it is *attracted* by the earth or any third body by twice as great a force. The first measure of mass is sometimes called inertia and the second is often, in daily life, called weight, and it is remarkable that these two measures agree with each other to a great degree of precision. One might expect, therefore, that an hypothesis as to the constitution of matter which clears up the nature of inertia, even provisionally, would throw some light upon the nature of gravitation, but it does not seem to be so, and Professor Fessenden must needs say more from his point of view and with greater precision before we shall be convinced. The difficulty to be encountered in the explanation of gravitation from the point of view of the electron hypothesis, as Johnstone Stoney calls it, seems to be as follows:

Imagine all corpuscles to consist of equal positive or negative charges, this indeed is assumed by J. J. Thomson, the only present need of this assumption is to permit of simple statements. Then, if those approximate facts which we call the laws of electrostatics were true, Newton's law of gravitation (?) would have to do only with *electric attraction and repulsion*, and it would run thus: every corpuscle of matter in the universe attracts or repels every other particle with a force which is inversely proportional to the square of the distance between them.

Two opposite charges may be said to be equal in value when they are acted upon by equal and opposite forces when placed in a uniform electric field. Now if two such charges of opposite sign attract each other with a slightly greater force than the force of repulsion of two precisely equal charges of the same sign, then two aggregations of equal numbers of positive and negative corpuscles would on the whole attract each other, because the oppositely charged corpuscles in the two aggregations would attract each other a little more than the similarly charged corpuscles would repel. Thus gravitation would be due to the fact that the *attraction* of equal and opposite charges would be slightly greater than the *repulsion* of like charges of the same value. This inequality of attraction and repulsion of equal charges would exist if the relation between stress and strain in the ether were not a linear relation, that is, if ether strain were not proportional to ether stress, for in the case of opposite charges the ether stresses are on the whole more iutense and less widely distributed than are the ether stresses in case of two like charges of the same value at the same distance apart. It would be a comparatively simple matter to determine the amount of deviation from proportionality of stress and strain which would suffice to account for gravitation. But the outstanding difficulty would be to explain the high velocity of propagation of gravitation which seems to be required by the known behavior of the solar system under the action of the sun's gavitation.

Of course it may be that the failure of the linear relation between ether stress (electric field) and ether strain is associated with ether compression, and it might be possible to explain in this way the high velocity of the propagation of gravitation. The point, however, which we wish to emphasize is that mere ether compression alone is not sufficient to explain gravitation; at least the compressional energy must not be proportional simply to the square of the resultant field intensity, for in this case the compressional energy would not be distinguishable from the distortional energy which gives rise to the ordinary electric attraction and repulsion. If, however, the compressional energy were proportional to the fourth power of the resultant field intensity, then the ether compression would not stand in a linear relation to electric field intensity (ether stress), and the above remarks concerning excess of the electric attraction over repulsion would apply and gravitation would be provisionally explained.

W. S. Franklin.

THE HOMING INSTINCT OF A TURTLE.

To the Editor of Science: The following account from a friend, Miss Victoria Hayward, of Bermuda, may be of interest to your readers. I can vouch for the accuracy of the relater, and know from experience that the locating of an area on the reefs is as easy to a Bermudan as if it were on dry land. Miss Hayward writes:

"My father caught a turtle in June that weighed seventy-five pounds. He placed it in a pond in the harbor of St. George. In August on going to the pond he found that some person had thrown a piece of iron weighing about fifty pounds into the pond and it had broken a large hole in the turtle's back. It had been wounded apparently about a week and was weak and seemingly dead. My father thought he had better kill it, but he changed his mind, and let it go alive into the harbor.

"In the latter part of October he and another man recaptured it in the same place where they had caught it before—about four miles from land, on the flats (reefs) that lie to the north of the islands. The back was nicely healed and the turtle was altogether in excellent condition. You know that it requires no little knowledge of the art of navigation for a turtle to find the way from the southern side of St. George's Harbor through some one of the many little channels to its own special home on the north reefs—four miles out to sea."

C. L. Bristol.

BOTANICAL NOTES.

PEACH LEAF CURL.

According to a bulletin (No. 20) prepared by N. B. Pierce and recently issued by the Division of Vegetable Physiology and Pathology of the United States Department of Agriculture, this disease appears to exist wherever the peach is grown. It is known to occur in North America, South America, Europe, South Africa, New Zealand, Australia, Japan and China. It is due to the presence of a minute parasitic fungus—*Exoascus deformans*—one of the simpler of the sac fungi—(Ascomyceteae). The fungus attacks the parenchyma of the leaves and twigs, enlarging, thickening, curling and distorting them. Eventually the leaves become yellowish and fall off, involving as a consequence the wilting and dropping of the fruit. It has been estimated that the annual loss in the United States from this source alone amounts to between two and three millions of dollars.

Mr. Pierce's paper discusses not only the structure of the fungus and the nature of the disease, but includes records of the many experiments which he made in order to determine what are the most efficient means for preventing or combating the disease in the orchard. He recommends spraying with Bordeaux Mixture of the following proportions: Copper sulphate, five pounds; lime, five pounds; water, forty-five gallons; applying it with what is known as a 'Cyclone Nozzle,' and doing the work from one to three weeks before the opening of the blossoms in the spring.

A NEW BOTANICAL JOURNAL.

MR. A. A. HELLER, the well-known botanical collector of Lancaster, Pa., has issued the first number of a new botanical journal bearing the euphonious name of *Muhlenbergia*. This first number is an eight-page octavo, well printed, on good paper. The prefatory editorial statement indicates that it is to be somewhat like Professor E. L. Greene's *Pittonia*, appearing, like that journal, at irregular intervals, and serving largely as the personal organ of its editor. The present number is devoted entirely to 'Some Changes in Nomenclature,' in continuation of the first pages of the 'Catalogue of North American Plants,' recently issued by the same author. Other numbers are promised to appear 'at early dates,' and they are to contain 'articles of general interest, both technical and non-technical, treating not only of flowering plants and ferns, but of the lower cryptogams as well.'

ENGLER'S 'PFLANZENREICH.'

THE indefatigable Berlin botanist who has brought one great work—'Die Natürlichen Pflanzenfamilien'—almost to completion, now undertakes a still greater work under the title 'Das Pflanzenreich.' The former treated of the families of plants, and the arrangement and brief characterization of their genera; the latter is to give full descriptions of genera, and diagnoses of all their species. The 'Pflanzenfamilien' was in fact a Genera Plantarum, supplementing, and to some extent supplanting, Bentham and Hooker's 'Genera Plantarum'; the 'Pflanzenreich,' on the other hand, is to be a universal 'Species Plantarum.' It is by all odds the greatest work in systematic botany ever undertaken.

It will be issued in the form of monographs, each family receiving separate treatment. For the present the work will be confined to the *Embryophyta siphonogama* (*Spermatophyta*), but it is the intention of the editor to take up later the *Embryophyta asiphonogama*, and ultimately the *Euthallophyta* and *Myxothallophyta*. The families are numbered, and the monographs will appear as fast as they are completed. The first one to appear is Family 45—Musaceae—from the pen of Dr. Karl Schumann. Its treatment is such as to assure us of the most satisfactory results. In particular are the excellent illustrations to be commended.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

PRACTICAL RESULTS OBTAINED FROM THE STUDY OF EARTHQUAKES.

FROM observations on the destructive effects of earthquakes, the knowledge obtained respecting the actual nature of earthquake motion, and from experiments made upon brick and other structures, new rules and formulæ for the use of engineers and builders have been established. In Japan and other countries, these have been extensively applied in the construction of piers for bridges, tall chimneys, walls, ordinary dwellings, embankments, reservoirs, etc. Inasmuch as the new types of structures have withstood violent earth shakings, whilst ordinary types in the neighborhood have failed, it may be inferred that much has already been accomplished to minimize the loss of life and property.

The application of seismometry to the working of railways, particularly in Japan, has led to the localization of faults on lines, and alterations in the balancing of locomotives. The result of the latter has been to decrease the consumption of fuel.

Records of the unfelt movements of earthquakes indicate the time, the position, and what is of more importance, also the cause of certain cable interruptions. The practical importance of this latter information, especially to communities who may by cable failures, be suddenly isolated from the rest of the world, is evident. The many occasions that earthquake records have furnished definite information respecting disasters which have taken place in distant countries, correcting and extending telegraphic reports relating to the same, is another indication of the practical utility of seismic observations. Seismograms have frequently appraised us of sea waves and violent earthquakes in districts from which it is impossible to receive telegrams, whilst the absence of such records has frequently indicated that information in newspapers has been without foundation, or at least exaggerated. The localization of the origins of these world shaking earthquakes, beside indicating the sub-oceanic sites of geological activity, positions where the hydrographer may expect to find unusual depths. They have also shown routes to be avoided by those who lay cables.

Seismograms of unfelt movements throw light upon what have up to recently been regarded as unaccountable deflections in the photograms from magnetographs, barographs, and other instruments sensible to slight displacements. They have also explained unusual rates in certain time-keepers. The most important scientific result obtained is dependent upon observations on the rate at which motion is propagated in various directions through the world. Until these observations had been made, our knowledge respecting the interior of the earth, chiefly related to its density and temperature, now we know much respecting its rigidity.

John Milne.

SCIENTIFIC NOTES AND NEWS.

Otto H. Tittman, assistant superintendent of the U. S. Coast and Geodetic Survey, has been promoted to the superintendency, vacant by the resignation of Dr. Henry S. Pritchett, to accept the presidency of the Massachusetts Institute of Technology. Mr. Tittman has been connected with the Survey since 1867.

Professor John C. Smock, for the last ten years geologist of the State of New Jersey, has tendered his resignation.

Mr. Outram Bangs has been appointed assistant in mammology in the Museum of Comparative Zoology at Cambridge, Mass.

Sir Joseph Hooker, the eminent English botanist, has been elected a foreign associate of the Paris Academy of Sciences.

Lord Lister has resigned his position on the Senate of the University of London as representative of King's College, and Dr. Thomas Buzzard has been appointed in his place.

Mr. Evelyn B. Baldwin has sailed for Europe to examine methods of polar exploration, and to secure equipment for the proposed expedition under the auspices of Mr. Ziegler.

Professor Carl Gegenbaur has received the Swammerdam medal of the Amsterdam Society of Medical and Natural Science.

Mr. Leroy Anderson, who was this year called from Cornell University to the University of California as instructor on dairy husbandry, has been offered the position of chief agriculturist in the Philippines. Mr. Lawrence M. Jacobs, of the Treasury Department, has been appointed statistician of the Taft Philippine Commission.

Dr. A. Donaldson Smith, after lecturing before the Royal Geographical Society, has returned from England to his home in Philadelphia.

Dr. Robert T. Hill, of the U. S. Geological Survey, non-resident lecturer to the University of Michigan, is now delivering a series of lectures at that University on 'The Industrial Significance of the West Indies to the United States.'

An executive committee has undertaken to erect a bust of the late Professor J. B. Carnoy in the cytological laboratory established by him in the University of Louvain. An honorary international committee has been formed, including in America Messrs. Agassiz, Eigenmann, Macallum, McMurrich and Minot.

It is proposed to found two memorials in honor of the late Miss Mary Kingsley, one a small hospital at Liverpool for the treatment of tropical diseases and one a Society for the study of the natives of West Africa. It is planned "that the 'Mary Kingsley Society' should employ a trained ethnologist, both to collect and arrange in scientific form the material which is thus already on record, and to institute and direct research for further material of the same sort; and it is intended that the Society, after the manner of the Royal Asiatic Society, should periodically publish the results which it obtains and should thus provide additional knowledge by which European relations with West Africa may be most safely and effectively directed, with profit both to the natives and to the Empire."

Dr. Burke Aaron Hinsdale, professor of the science and art of teaching at the University of Michigan since 1888 and the author of various publications on education and history, died on November 29th aged 63 years.

Professor Marshal Oliver, of the Department of Marine Engineering, U. S. Naval Academy, died on November 26th at the age of 57 years.

Professor George Frederick Armstrong, professor of engineering at Edinburgh University, died on November 14th. He was born in 1842 and became professor at Edinburgh in 1885.

Dr. John Cockle, who was one of the oldest members of the medical profession in Great Britain, having qualified as a member of the Royal College of Physicians in 1835, died on November 14th. Dr. Cockle was in 1897 president of the Medical Society of London and was the author of various papers on diseases of the heart and of the organs of respiration, on the poison of the cobra, etc.

The ninth annual meeting of the American Psychological Association will be held at Johns Hopkins University on December 27th, 28th and 29th, under the presidency of Professor Joseph Jastrow.

The American Physiological Society will hold its thirteenth annual meeting in Baltimore on Thursday and Friday, December 27 and 28, 1900. The usual smoker will be held on Wednesday evening, December 26th. Those who will require apparatus or other necessities for the making of demonstrations may communicate with Professor W. H. Howell, Johns Hopkins University.

Dr. Adam Paulsen, director of the Meteorological Institute of Copenhagen, has gone to North Finland to study the aurora. He undertook a similar expedition last winter to North Iceland.

Mr. Marshall H. Saville, of the American Museum of Natural History, sailed from New York, on November 21st, for Mexico, where he will spend some six months exploring the ruins of Mitla.

Mr. Alfred P. Maudslay passed through New York on November 27th, on his way to Oaxaca, Mexico.

Mr. Walter R. Harper has explored some rock-shelters near Port Hacking, New South Wales, finding stone axes at a depth of five feet. Bone needles were also found in the same deposits.

According to Reuter's Agency advices from Laurvig announce that Captain Stökken arrived there on November 20th, and expressed his readiness to take part in the expedition being organized by the Duke of Abruzzi, who is now at Laurvig, to search for the three missing men of the Duke's former expedition, among them being a son of Captain Stökken. The expedition will probably start from Götenborg on board the whaler *Cappella*, which has been chartered by the Duke and will probably reach Franz Josef Land in the middle of July. The island will then be thoroughly searched. The expedition will be composed solely of Norwegians.

We learn from *Nature* that early in the summer a memorial was submitted to the Governments of South Australia and Victoria praying that facilities might be granted to Mr. Gillen, one of the inspectors of aborigines, and Professor Baldwin Spencer for the continuance of their investigations into the habits and folk-lore of the natives of Central Australia and the Northern Territory. The memorial, which was signed by all British anthropologists and many prominent representatives of other sciences, has met with a prompt and generous response. The Government of South Australia has granted a year's leave of absence to Mr. Gillen, and the Government of Victoria has provided a substitute for Professor Spencer during his absence from Melbourne. Mr. Syme, the proprietor of the Melbourne *Age*, has contributed $5,000 towards the ordinary expenses of the expedition. The Government of South Australia has also allowed the expedition to make use of the depôts and staff of the Transaustralian telegraph for the forwarding and storage of supplies. The explorers start in February, and it may be confidently anticipated that, if the winter rains make conditions favorable for traveling, they will be rewarded with the same conspicuous success which attended their expedition of three years ago; although the task before them requires even greater tact, since the natives of the Northern Territory are more difficult to deal with than the aborigines of the center, who know Mr. Gillen and regard him with the utmost confidence. The tribes of the MacDonnell Ranges will be studied even more minutely than before, and afterwards the explorers will go towards the Gulf of Carpentaria, along the Roper River, and, time permitting, proceed down the Daly and Victoria Rivers.

According to a despatch from Berlin dated December 1st, the Duc de Loubat has presented to the Berlin Museum of Ethnology a valuable collection of Central American antiquities.

Mr. Frederick Stearns, of Detroit, who gave the Stearns collection of musical instruments to the University of Michigan, has sent word from Europe, where he now is, that he has purchased two hundred more instruments to be added to the collection.

Mr. Richard James Wilkinson, of the Straits Settlements Civil Service, has presented to Cambridge Uuiversity his entire collection of books in the Malay language amounting to 63 MSS. and about 50 lithographed or printed volumes.

Ex-Governor Pillsbury, of Minnesota, has given 1,000 acres to the State Forestry Board for the purpose of encouraging State forestry reserves in Minnesota and giving the State Board a chance to experiment with cut-over timber tracts, with a view to determining the extent to which the growth of timber can be renewed. Mr. Pillsbury specifies that two-thirds of the revenues which may be derived from his gift must go to the State University at Minneapolis.

At the monthly meeting of the London Zoological Society on November 24th, it was stated that during the months of August, September and October there had been 483 additions made to the Society's collection of living animals, among which special attention was called to two tenrecs (*Centetes ecaudatus*), deposited by the Hon. Walter Rothschild, M.P.; to a Ludwig's bustard (*Eupodotis Ludwigi*) from Port Elizabeth, presented by Mr. J. E. Matcham, and to a bouquet's Amazon (*Chrysotis bouqueti*) from Dominica, West Indies, acquired by purchase, all new to the collection. It was also stated that during the same period there had been 270,578 visitors to the Society's gardens, being an increase of 11,241 as compared with the corresponding period in 1899. The receipts under this head of income consequently showed during this period a substantial increase. The meeting adjourned until December 20th next.

The report of the Austrian Medical Commission of the Vienna Imperial Academy of Science, sent to Bombay, in 1897, to study the plague, states that some animals, including man, may be readily infected when the virulent matter is rubbed on the skin, even though the latter be totally free from any lesions. The report also gives evidence to show that perfect immunity can be given to the most susceptible animals. It will be remembered that the work of the commission was cut short because of the accident resulting in the death of Dr. Müller in 1898.

The Pekin correspondent of the London *Times* cables: "In pursuance of their regrettable policy of appropriation, the French and German generals, with Count von Waldersee's approval, have removed from the wall of Pekin the superb astronomical instruments, erected two centuries ago by the Jesuit fathers. Half of them will go to Berlin and the rest to Paris. The explanation of this act of vandalism is that, inasmuch as the return of the court is so improbable, such beautiful instruments should not be exposed to the possibilities of injury when Pekin is no longer the capital."

The experimental and chemical departments of the research laboratories of the Royal Colleges of Physicians and of Surgeons on Victoria Embankment have been completely reorganized aud are now well equipped for the carrying out of research work. During the year a grant of £100 has been voted by the laboratories committee to Mr. W. P. Bloxam, B.Sc., for his work upon the chemistry of antitoxic bodies. A grant of £25 was voted to the director for expenses incurred in his work upon the same subject from the Goldsmiths' Company's research grant. The research grant has also been utilized in supplying antitoxic serum to various general and children's hospitals. The report gives descriptions of 204 specimens added to the physiological series of the museum, and also of various preparations added to the pathological series. The library contains more than 50,000 volumes, and is being increased at the rate of about 1,000 volumes a year. It is particularly rich in the transactions of societies and in periodicals, relating not only to medicine and surgery, but also to accessory sciences. The library includes a collection of portraits of members of the medical profession.

WE learn from *Nature* that a private conference was recently held at the Board of Trade to consider the protection of the delicate instruments in use at Kew and Greenwich Observatories from magnetic disturbance, through the working of tramways and railways in the metropolis by electricity. Sir Courtenay Boyle presided, and among the officials of the Board of Trade present were Mr. F. J. S. Hopwood, Sir Thomas Blomfield and Mr. Trotter. The observatories and kindred public departments were represented by Mr. Christie (the Astronomer-Royal), Professor Rücker, Mr. Glazebrook (Director of the National Physical Laboratory), Lieutenant-Colonel Raban (Director of Works at the Admiralty), Admiral Sir W. J. Wharton (Hydrographer to the Admiralty), and Professors Ayrton and Perry. Among those who attended as representatives of the railway and tramway interests concerned were Mr. George White (chairman) and Mr. J. C. Robinson (engineer) of the London United Tramways Company, Sir Benjamin Baker and Sir W. Preece.

MR. E. C. OLIVER of the mechanical engineering department of the University of Illinois, has succeeded, with the advice of Professor Breckenridge, in perfecting an automatic recording machine which records automatically different data with regard to the speed and power of engines. The recorder can be applied to either gas or steam engines or to a dynamometer car, and is capable of taking any, one or all, of eight readings by means of ink pens on an endless roll of paper. The recorder gives faithfully the speed of the engine, the number of the horse power exerted, the rate of the occurrence of the explosions and the number of revolutions per minute of a gas engine.

MR. HUGHES, United States Consul at Coburg, reports that in Coburg and neighboring parts of Germany considerable attention is being paid to electrical appliances that can be used on the farm. Near Ochsenfurt, in Bavaria, a company, composed of land owners and small farmers, has been organized for the establishment of an electrical system for use on their farms and in villages. The power is to be generated by steam and water and the current to be distributed from a central station to the places at which it is wanted. Sub-stations are to be established at given points, with the necessary apparatus for connecting with the farm or other machinery and also for lighting purposes in the houses, offices, roads and village streets.

THE Dutch cabinet submitted to the States General, on November 14th, a new bill proposing to drain the entire Zuyder Zee.

THE field work of the Division of Forestry of the Department of Agriculture, which has been carried on in many parts of the country by parties of different sizes since last May, has now been largely completed for 1900. This summer's work was carried on in New York, Tennessee, Missouri, Colorado, South Dakota, Arkansas, Arizona, Washington, Oregon, California, a number of tree-planting States of the Middle West and, in a small way, in other States besides. Much new and valuable information has been collected, and a very large number of surveys has been made, of the results of which it will soon be possible to make practical use. The work which has thus been going on in the field consisted of making forest surveys and of gathering measurements and information about growth, stand, reproduction, etc. Much of it, as that in the Black Hills Forest Reserve, in the Adirondacks, and on the tract of the Sawyer & Austin Lumber Company in Arkansas, is preparatory to the preparation of what are called 'working plans,' or plans for the management and utilization of given tracts of timber. These are based not on any general rules, but on a thorough knowledge of the peculiarities of the forest on each tract, of the market and transportation facilities of the regions in which they are situated, and of the financial necessities of each case. The rest of the work of the field parties has been more of the character of investigations—as, for instance, the examinatiou of the influence of forest cover on waterflow which was made on the watershed of the Arrowhead river in southern California, the studies of the habits of growth and reproduction of the two most important lumber trees of the Pacific coast—the Red Fir and the Redwood, and the survey of the results of tree-planting undertakings which have been carried on in the northern part of the Mississippi Valley. During the coming winter the agents of the Division will spend most of their time in working up the results of the summer's surveys and in preparing reports on them, although there will doubtless be some field work as well.

The total exports from the United States during the month of October, as shown by the records of the Treasury Bureau of Statistics, were $163,093,597. The total for ten months ending with October, 1900, is $1,194,775,205, or practically double that of the ten months ending with October, 1894. Exports exceeded imports during the ten months ending with October by $499,667,936, while in the corresponding ten months of 1894 imports exceeded exports by $96,663,369. The exports of last month were far in excess of any previous month, exceeding those of March of the present year, which hitherto had the highest record, by nearly $30,000,000.

UNIVERSITY AND EDUCATIONAL NEWS.

Yale University has received $68,152 from the estate of the late John De Kovey.

In an address to the students of Colorado College, Dr. D. K. Pearsons, of Chicago, announced that on January 1, 1901, he would make the college a gift of $50,000 toward the cost of completing the new scientific building now in course of construction.

Under the will of the late Dr. D. J. Leech, professor of materia medica and therapeutics in the Owens College, Manchester, that college will eventually receive £10,000, for endowing a chair of materia medica and therapeutics.

The University of Wisconsin has received $1,000 from Charles F. Pfister and a like amount from Fred Vogel, both of Milwaukee, to be expended in the purchase of books for the School of Commerce.

The Yale University treasurer has bought an additional piece of property on Cedar Street in New Heaven, by which, with earlier purchases, a continuous front of about 200 feet opposite the New Haven Hospital is secured for a new site for the Medical School, at a total cost of about $60,000.

Dr. de Wilde, minister from the Argentine Republic, is interested in the establishment of ten agricultural and mechanical colleges in that country after American models. To this end there are twenty-eight students of the Republic now attending colleges in this country, both in the East and the West.

In a letter to the *Times* Mr. T. Clifford Albutt states that in spite of constant efforts during the last two years the Chancellor of Cambridge University has received no more than £62,500, one half of which amount comes from the Chancellor himself, Lord Rothschild and Mr. Astor. "These funds are now being expended on the laboratories and museums of geology, botany, and pathology, which are most needed; but they will not meet the cost even of these; the botanical and pathological departments alone will cost more. Again, among the offices still vacant here for lack of funds are twenty-three of the readerships prescribed by the Commission as necessary. The normal salary of a reader is £400 a year; I should be surprised to hear that the average income of our present readers is more than £200. Our revenue on paper seems large no doubt, but the bulk of it is in trust for specific purposes, some of which are and some are not of paramount importance; every penny, however, that could be set free for development was so freed by the Royal Commission. * * * Unless the public by donation or bequest be more generous, we can hardly hope to keep in the van of modern education; yet for Oxford and Cambridge to fall back would be a national misfortune."

J. Shirely Eaton, the statistician of the Lehigh Valley Railroad, has been elected to a chair of domestic commerce and transportation at New York University.

SCIENCE

FRIDAY, DECEMBER 14, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ANNUAL REPORT OF THE SECRETARY OF AGRICULTURE FOR 1900.

SECRETARY WILSON begins his report with a complimentary reference to the work of his predecessors which has brought the Department of Agriculture to its present state of efficiency. He declares his own aims to bring the Department scientists to the help of the producers, to ascertain what we import that they can produce, with a view to encouraging its growth ; to search the world for grains, fruits, grasses and legumes, that they may be domesticated here and be an improvement on what we have ; to secure new and improved varieties of plants by cross-fertilization ; to cooperate with the experiment stations in all the States and Territories in research of practical value to the people of all sections ; and to seek out new markets for our surplus products.

Mr. Wilson emphasizes the manner in which this Department differs from others. He says its appropriations should be regarded as an investment, for the reason that it makes direct returns therefor by adding to the wealth of the country, thus adding yearly largely to the profits of the farmers and others as the result of its investigations. He instances as money-saving or money-making agencies the Weather Bureau ; the meat inspection ; the pathological investigations of plants ; the services of the entomologist ; the services of the

Department on behalf of sugar and tea industries, of the orange industry, which owes its beginning and its preservation to this Department, of the tobacco industry, and others.

Then taking up the work of the Department in more detail, he reviews the operations of its several branches.

WEATHER BUREAU.

Important extensions of the Weather Bureau work have been made during the past year. Its efforts were specially directed to investigate methods of electrical communication without wires, with a view to establishing wireless electrical communication between vessels at sea and exposed points on our lake and sea coast. New appliances have been devised and receivers constructed more delicate than any heretofore made. Already messages have been successfully transmitted and received over 60 miles of land presenting a rough and irregular surface, and it is believed that the efficiency thus indicated would operate successfully over several hundred miles of water. This matter, says the Secretary, is of such importance to commerce that he has authorized further extensive experiments, and he expresses the hope that in the near future the craft employed in our coastwise commerce and on the Great Lakes will be placed in instantaneous communication with the stations of the Weather Bureau located at the principal ports.

Special storm forecasts for the North Atlantic will be undertaken shortly through the use of reports received from the West Indies, the Bahamas, Bermuda, the Azores, and Portugal, the new cable system connecting Lisbon with New York via the Azores making this possible. Much stress is laid upon the continued improvement of the forecast service and the value of its warnings. He points out that, notwithstanding the great number of craft plying the Gulf of Mexico at the time of the Galveston storm, the warnings were so timely that there was no disaster upon the open waters.

BUREAU OF ANIMAL INDUSTRY.

The number of abattoirs and packing-houses receiving the benefit of inspection was 148 in 45 localities, as against 138 in 41 localities the preceding year. The total ante-mortem inspections of cattle aggregated 53,087,994; animals rejected, subject to post-mortem, at abattoirs, 5,928; and in stock yards, 153,561. The total post-mortem inspections were 34,737,613, and the total carcasses condemned, 61,906. In the microscopic inspection of pork 999,554 carcasses were examined. Of these but 19,448, or 1.95 per cent., were found to contain living trichinæ. The total cost of inspection was but a few dollars over $700,000. Of vessels inspected by officers of the Bureau, 862 received clearances. Of the cattle shipped across the Atlantic, the loss amounted to but .24 per cent.; of sheep, .71 per cent., and of horses, 2.55 per cent. It is interesting to note the great increase in the number of horses exported. Of these, over 29,000 were landed from American ports at London, Liverpool and Glasgow.

During the quarantine season of 1899 over a million cattle were moved under the supervision of the Bureau from the district infected with the Southern cattle tick. In Texas alone, over 357,000 cattle were inspected for shipment to other sections. The sheep industry has suffered greatly from sheep scab, and much time and attention have been given to securing its control and eradication. Results so far are encouraging, and the Secretary believes that a few more years of earnest work will effectually eradicate the disease. Over 1,800,000 sheep were inspected, and nearly 627,000 dipped under the supervision of the inspectors.

The work of preparing serum for treating hog cholera and swine plague, and experiments in treatment therewith, are continued, with results which, while they do not justify definite conclusions as yet, are sufficiently encouraging to justify continued experiments, including some on entirely new lines. Over one million doses of blackleg vaccine have been distributed during the year. Summarized reports of 2,000 cattle owners testify to its efficiency. Whereas a loss of 10 to 25 per cent. of young stock is reported in the districts where blackleg prevails, the loss where vaccination has been tried has been less than one-half of one per cent. From two to two and a half million doses will be required to supply the demand during the current fiscal year. The Bureau has already distributed 10,722 doses of mallein for testing horses for glanders, and 33,400 doses of tuberculin. Considerable space is given to the consideration of tuberculosis, 'the most prevalent and most destructive disease affecting mankind and the domesticated animals.' A great increase in the disease is noted in the principal countries of Europe, especially, unfortunately, in those whence American breeders desire to obtain animals for improving their stock. Arrangements have been made to station an inspector in Great Britain to test and certify to the animals before shipment. The suggestion is made that uniform regulations under Federal authority will save shippers much annoyance and loss, owing to the numerous restrictions imposed by individual States, and at the same time furnish adequate protection.

With regard to rabies the Secretary declares that this disease is unfortunately on the increase in the United States, and that local authorities have in most cases not efficiently controlled its outbreaks. He refers especially to its existence and increase in the District of Columbia, and points out the special danger to children from rabid dogs. Owing to the very serious expense to families in moderate circumstances in subjecting their children to the Pasteur treatment, he recommends either that the Secretary of Agriculture be authorized to pay for such treatment for parties bitten in the District, or that one of the medical services of the government be directed to furnish such treatment free of charge.

The report states that ticks received from Porto Rico have been found identical with the well-known Southern cattle tick. The main problem still presented by the Texas fever question is the finding of a dip that will effectually destroy the tick without injuring the cattle. Efforts in this direction are to be continued.

Experimental shipments of dairy products are still continued, and shipments of butter have been extended to Cuba and Porto Rico. The Department is seeking to obtain information useful to butter exporters in canning butter and producing butter especially adapted to shipment to warm countries. Some countries sending butter to these markets show a disposition to adapt their products to the needs of those countries, which is an example our producers must follow if they are to compete successfully with them. The Secretary earnestly recommends an inspection of dairy products designed for export. He points out the example of other countries, whose large foreign trade in dairy products has been principally developed owing to the fact that their best products bear a Government stamp, guaranteeing the article to be as represented.

DIVISION OF CHEMISTRY.

Elaborate work in the investigation of food adulteration has been continued. Over 500 samples of preserved meats of all kinds, purchased in open market, have been examined. The meat of the horse has been examined for the discovery of a method whereby it may be detected when sold under another name. Very little of it seems to be sold in the United States, whether under its own name or any other name. Active cooperation has been had with other bodies, notably the Pure Food Congress, in an effort to secure legislation on the subject of food adulterations. National legislation on the subject is urged as essential to supplement and make efficient the work done in the several States. The sugar-beet work has been prosecuted with vigor and intelligence. Foreign food products introduced into this country have been the subject of careful study. The results are confidential and are used for the information of the authorities of this country controlling imported food products. Cooperation of the chief chemist has been invited in several other directions and always cheerfully extended. So, also, there has been cooperation with the other divisions of the Department where chemical work has been necessary.

DIVISION OF ENTOMOLOGY.

Most satisfactory reports are received from California as the result of the entomological work in the introduction of the insect which fertilizes the Smyrna fig. In one locality more than six tons of Smyrna figs have been produced. The result will be to make America a grand competitor in the fig trade of the world's markets. An important parasite has been introduced to prey upon the olive scale, so injurious to the olive growers of California. From Natal a fungous disease has been introduced by which injurious swarms of locusts have been destroyed. Efforts have been made to introduce European parasites of the gypsy moth.

DIVISION OF BOTANY.

The results of seed testing are declared to be satisfactory and to have greatly improved the quality of the seed distribution by Congress. Further improvement, however, is necessary in purity of stock or trueness to name. As the new seeds and plants introduced from foreign countries demonstrate their adaptability, they will become available for Congressional distribution. Experts of the Division had been studying plants poisonous to stock in Montana, and a report on the subject will be soon forthcoming. Valuable experiments will be conducted upon the ground set aside for the use of the Department on the Potomac Flats at Washington. Especial attention is called to experiments with American clover seed, which have shown that the American seeds are decidedly more valuable than the European.

SECTION OF SEED AND PLANT INTRODUCTION.

Seed and plant introduction receives extensive notice, special stress being laid upon the importations of cereals, including the macaroni wheats of Southern Europe, of grasses and forage plants and of vegetables which have already demonstrated their value. The Kiushu rice introduced from Japan has already added 1,000,000 bushels annually to the Louisiana rice crop. The successful introduction of date trees in Arizona is another valuable achievement. In concluding this subject Secretary Wilson cites the introduction of wheats from Russia, Hungary and Austria, greatly exceeding in yield our present varieties, and points out that if, as the result of these introductions, the wheat yield of the United States should be increased by but one bushel per acre, this would mean at the farm price for wheat in 1899, an addition of $26,000,000 to the income of our farmers.

DIVISION OF VEGETABLE PHYSIOLOGY AND PATHOLOGY.

This work is now divided into five important branches, namely, plant pathology, plant physiology, Pacific coast investigations, plant breeding and plant nutrition and fermentation. The Secretary believes that excellent results will be obtained from the systematization of the work of this Division. In plant breeding orange hybrids have been placed at various points in the South, and their value has been tested in cooperation with several experiment stations. In corn breeding the features aimed at are early maturity, drought and smut resistance, increased protein content, and a large yield. Diseases of the sugar beet have been investigated, also diseases of forest trees. The transfer of Mr. B. T. Galloway as chief to the Directorship of Plant Industry, and the succession to the chiefship of Mr. A. F. Woods are noted.

DIVISION OF POMOLOGY.

The most important work of the year in this line was the establishing and maintaining at the Paris Exposition of an exhibit of horticultural implements, seeds, plants and fruits. This exhibit attracted wide attention, and the Secretary believes its ultimate effect will be most beneficial to American producers. No other country, it seems, attempted to maintain a continuous fresh-fruit exhibit. A special effort has been made to give a thorough test to the cultivation of choice European grapes in the South Atlantic States.

DIVISION OF AGROSTOLOGY.

This work has also been divided into several sections and thoroughly systematized. As a result of experiments in Texas, the grazing of pastures has been so much improved that, where three years ago they were estimated as capable of supporting one steer to 16 acres, they will now maintain in good condition one steer to 8 acres, a gain of 100 per cent. Among the objects of cooperative effort are the following: Range improvement, formation and management of meadows and pastures, forage plants for alkali soils, soiling crops, winter pasturage, etc. Particular attention has been devoted to collecting seeds, roots, and plants of notable native grasses. The grass garden on the Department grounds, containing nearly 500 varieties, has been maintained, and seeds of some 200 varieties have been distributed.

DIVISION OF GARDENS AND GROUNDS.

The Secretary refers in most complimentary terms to the late Mr. Saunders, so many years in charge of this and other important branches of the Department work, and reports the transfer of the experimental gardens and grounds, since Mr. Saunders's death, to the control of Mr. B. T. Galloway. Considerable space is given to tea production in the United States and to the opportunity this industry affords of utilizing the labor of colored children in the South, while at the same time affording them a good education. The claim is made that it has been demonstrated that tea can be produced in the United States for family use in gardens and also on a commercial scale. It has been shown that a good grade of tea can be produced for 15 cents a pound, or about $60 per acre, counting an average yield 400 pounds. Such tea should sell for at least 30 cents. In future special attention will be given to the manufacture of green tea.

BIOLOGICAL SURVEY.

The destruction of prairie dogs has become a practical question of great interest to farmers, and is being investigated by the Department. Warning is given of the possible danger of the introduction and dissemination of the Belgian hare. It is reported by the State Board of Horticulture in California that several thousands of these animals are now at large throughout the State, and their rapid multiplication will make them a source of great injury. Laboratory work and study of the food of birds of economic importance have received attention. Special note is made of the Lacey Act, by which the Secretary of Agriculture is charged with the supervision of the importation of birds contemplated by this Act of Congress. Congress has authorized the Secretary to adopt such measures as necessary to carry out the purposes of the Act; and it is urged that the present appropriation being inadequate for the purpose, an increase should be provided.

SOIL SURVEY.

This work has been greatly extended, but stills falls far short of meeting the demand for soil surveying from all sections of the country. For this reason a considerable increase has been asked for. Letters and resolutions endorsing the work and urging its extension as one of great practical value have been received from many individuals and organizations. Owing to its costliness, and the widespread demand for it, the Secretary recommends that Congress provide for the printing of the annual report of this Division, as is now done with the annual reports of the Weather Bureau and Bureau of Animal Industry.

The Secretary feels highly encouraged by the results of the work of this Division with tobacco. He notes especially the successful results of an attempt to grow the Sumatra leaf in Connecticut. Sumatra tobacco imported costs our consumers, with the duty, $15,000,000. Of this $6,000,000 goes to foreign producers. He believes that in a short time this will be saved for our own tobacco growers. The tobacco exhibit at the Paris Exposition was one of the largest as well as the most complete ever made. It contained over 2,000 samples. The Florida-grown Sumatra was awarded 20 points of merit against 18 points for Sumatra, and the bright yellow of North Carolina was awarded as many points as the Turkish tobacco with which it competes.

FORESTRY WORK.

There has been a great growth in this work, which is of such a kind as to fully justify additional resources. Moreover, there has been an enormous increase in the demand, both public and private, for services of this character throughout the country. The relations of the Division of Forestry with practical lumbermen and tree planters have been closer and more useful than ever before. The total membership of the force at the highest last summer was 125. The public interest in forest matters is not only keener and wider than at any time before, but it is growing with rapidity beyond precedent. Cooperation in forest work has been sought of this Department by the Secretary of the Interior in reference to the national forest reserves, and from the Forest, Fish, and Game Commission of New York, for working plans for the New York State Forest Preserves. The total requests for working plans at the close of the year exceeded 50,000,000 acres, of which two and a half millions were private land. Personal examinations were made of 48 tracts in 14 States, covering nearly 900,000 acres, plans were actually prepared for 200,000 acres, and 50,000 acres were put under management. Tree-planting plans were made for 59 applicants.

The department is receiving with increased frequency applications for planting and working plans for watersheds from which cities obtain their supplies. A typical instance is that of the Water Company of Johnstown, Pennsylvania, one of the chief objects being to prevent a recurrence of the disaster there.

Studies of commercial trees, with a view to ascertaining rate of growth and production and other facts germane to the best practical forestry, were considerably extended.

PUBLIC ROAD INQUIRIES.

There is much inquiry in all sections of the United States regarding better roads and better methods of building them. It has been deemed wise to divide the country into four sections, and to appoint in each an expert agent. This has been done, and one appointed in the Eastern States, one in the Southern, one in the prairie States, and another in the Rocky Mountain States. These gentlemen are to study the needs of these several sections, give instruction as to road building, and report regularly to the Department. They will, moreover, supply samples of road material for analysis and testing, a testing machine having been arranged for in the laboratory of the Division of Chemistry, to be operated by an expert under the joint supervision of the director of road inquiry and the chief chemist.

Much work has been done in the past year in cooperating with the colleges and stations and the people of the several States in building experimental roads, and generous acknowledgment is made of the services contributed to the cause of good roads by the various transportation companies throughout the country.

OFFICE OF EXPERIMENT STATIONS.

The Secretary reviews at considerable length the work of the experiment stations first established in this country twenty-five years ago. Until 1887, the date of the Hatch Act, stations had been established in only fourteen States. Under this Act the enterprise was extended to cover the entire country, and the great success which, on the whole, has attended the establishment of the stations in all the States and Territories is very remarkable. Including the $720,000 received from the National Government, the total revenues of the stations during the year amounted to $1,200,000. The stations now employ rearly 700 persons, and in 1899 their publications aggregated 445 reports and bulletins.

The Secretary advocates a more complete separation of the business of the station from the general business of the college, and, where possible, the appointment of a director of the station as a separate officer. He believes it to be a mistake, on the whole, to divert the time and energy of competent investigators to the routine work of inspection service. While the Department of Agriculture is by law organized as an administrative agency as well as a great scientific institution, the stations, on the other hand, are organized solely to carry on investigations for the benefit of agriculture.

Cooperative enterprises between the Department and the stations have increased in number, and also in scope and variety. Both the officers of the Department and of the stations are greatly interested in cooperation, which, it is believed, may be systematized and greatly extended, thus adding much to the efficiency of both the Department and the stations.

Progress is noted in the experiments conducted in Alaska, and the establishment of substations is recorded. It is admitted that Alaska can never become an agricultural country, but the problem the Department has undertaken to work out is to determine whether a sufficient agriculture may be developed in Alaska to form an important subsidiary industry to aid in the development of mining, fisheries and lumbering. It has already been shown that green vegetables raised in Alaska have been an important factor in maintaining the health of mining communities. There are large areas on the western peninsula and the islands naturally adapted to live stock. For a considerable period the Department's operations in this Territory will partake of the nature of an agricultural survey to determine where agricultural operations may be best carried on. The

Secretary makes a comparison of Alaska with Finland, which supports a population of 2,500,000 souls, and which produced in 1895 nearly 40,000,000 bushels of cereals, besides exporting nearly $7,000,000 worth of dairy products.

As the result of investigations in Hawaii and Porto Rico, the Secretary believes that experiment stations should be established in these dependencies, and that they should receive for this work an annual appropriation equal to that given to the other Territories.

Investigations on the food and nutrition of man have been continued, largely in cooperation with the stations and colleges. This subject is one touching every household, numerous public institutions and the army and navy, and the results obtained can be made of great practical value. Household economics is rapidly taking its place among the required studies of our institutions of learning.

Much consideration is given in the report to the irrigation investigations, which in accordance with the terms of the appropriation act, cover especially two general lines of investigation, namely, the study of the laws and institutions relating to irrigation in different regions, and secondly, the determination of the actual use made of irrigation waters.

Eight typical streams in different parts of California have been thoroughly studied with reference to the conditions under which the water for irrigation is owned, distributed, and used. Similar investigations on a smaller scale have been made in Utah, Colorado, and elsewhere. Interest in the use of irrigation to supplement rainfall in the humid regions is growing, and valuable investigations have been made in New Jersey and have also been undertaken in Missouri and Wisconsin in cooperation with the experiment stations in those States.

The Secretary calls attention to the fact that on the supply of water for irrigation and its equitable distribution depends the permanent existence of civilized life in one-third of the area of the Union. Throughout this vast region questions relating to irrigation are vital to the ultimate solution of its problems, and must be found not only in State legislation, but in the action of the National Government. Most of the streams used for irrigation cross State lines, while some run partly in foreign countries. What is needed in this matter at the present time above everything else is the impartial ascertaining and recording of the facts relating to irrigation in this country. It is this task which the Department has set for itself.

SECTION OF FOREIGN MARKETS.

The study of markets abroad with special reference to extending the demands therein for the agricultural products of the United States has been prosecuted with zeal and intelligence. From the records of this section we derive most satisfactory information as to the development of our agricultural exports. While it is true that these bear a somewhat smaller proportion to the total exports than formerly, nevertheless the actual increase is very great. During the fiscal years 1897–1900 our total sales of domestic farm products to foreign countries aggregated the enormous sum of $3,186,000,000, an excess of $800,000,000 over the preceding four-year period. The agricultural exports of the United States for the past fiscal year amounted to $844,000,000. The rapid growth of our export trade to the Orient in recent years is most striking. Five years ago our total shipments of domestic merchandise to Asia and Oceania were valued at $43,000,000, of which only $9,700,000 were agricultural. There has been a steady increase in each succeeding year, until in 1900 our export trade with the Orient amounted to $107,000,000, of which $30,000,000 worth was farm produce. Of this great increase in the growth of our agricultural exports to that quarter of the globe, amounting to something over $20,000,000, $11,500,000 consisted of cotton, and $3,400,000 of wheat flour.

During the past fiscal year Cuba, Porto Rico, the Hawaiian Islands and the Philippines furnished a market for $45,000,000 worth of our domestic products. Five years ago these islands took but $13,000,000 worth. During the fiscal year 1900 we sold to these islands $20,000,000 worth of farm produce, an increase of $13,700,000 over 1896.

DIVISION OF STATISTICS.

Efforts in this Division have been mainly directed to strengthening and improving the Department's several crop-reporting agencies. Two statistical field agents now devote their entire time to systematic visitation of the principal centers of agricultural industry. Much good is derived from their efforts. At the same time it is gratifying to state that the reports from the Department's regular correspondents have never before been so numerous, complete and prompt.

DIVISION OF PUBLICATIONS.

The Secretary notes with gratification that appreciation of the Department's work, as manifested in the demand for its publications, is every year more evident; so that with an annual output exceeding in the aggregate 7,000,000 copies, refusals to applicants are in many cases imperative. The number of new publications issued during the fiscal year was 320, against 297 for 1899; of reprints there were but 148 in 1900, against 306 in 1899; of Farmers' Bulletins 108 were issued, aggregating 2,360,000 copies. Even this enormous number fails to meet the requirements of Congress, which in this year's appropriations has provided for a still larger issue, and has reserved for the use of Senators, Representatives and Delegates four-fifths of the number printed, in lieu of two-thirds, as heretofore. The calls upon this Division from all parts of the country for publications, involved replies to 300,000 separate communications during the year, besides which more than 3,300,000 names and addresses had to be written in the distribution of documents.

THE LIBRARY.

Five thousand volumes have been added to the Library during the year, and cards have been issued to nearly 4,000 libraries, containing entries of all articles in the Yearbooks and Farmers' Bulletins issued to date.

ACCOUNTS AND DISBURSEMENTS.

Appropriations for the Department for the fiscal year ended June 30, 1900, amounted to $3,006,022, an excess over 1899 of $176,320. In addition, the usual sum of $720,000 was provided for division among the State agricultural stations. Expenditures and liabilities incurred during the year were $2,975,000. During the year $4,440 was paid for the rental of leased buildings in Washington.

PARIS EXPOSITION AWARDS.

The final official list of the Paris Exposition awards has not yet reached the Department, but preliminary reports supplied by its representatives in Paris record about 500 awards to United States exhibitors in agricultural, horticultural and food products. The United States was also generously considered in the forestry and tobacco classes.

AFFILIATION OF ALLIED LINES OF WORK.

The Secretary lays particular stress upon the necessity of adopting from this time forward a policy of aggregation rather than segregation in the development of the Department work, so as to bring together the related lines of work without, however, interfering in any way with the integrity of the organization of the several Divisions. He reports the affiliation in this manner of four important Divisions closely allied by the nature of their work under the name of the Office of Plant Industry.

LABORATORY BUILDINGS.

An urgent recommendation is made for the erection of new, fireproof laboratory buildings, which, it is estimated, will cost about $200,000.

DIFFICULTY OF RETAINING EXPERTS.

One of the problems constantly recurring to the head of the Department is the difficulty of retaining in the service some of the most capable and efficient of its workers. During the past year three valuable workers were lost to the Department, and other losses are threatened, owing to the tempting offers made to Department experts from other sources. The Secretary recommends that Congress place it in his power to exercise a wider discretion in the matter of salaries to responsible officers.

ARLINGTON FARM.

Under the authority of Congress work has been begun on the Arlington estate with a view to establishing an experimental farm on the land set apart for the use of the Department.

DOMESTIC SILK CULTURE.

In 1899 the United States paid over $32,000,000 for imported raw silk, and in 1900 over $45,000,000. The Secretary believes that a large amount of cheap and now unemployed labor among the colored youth in the Southern States could be made available for domestic silk cultnre; and he desires an appropriation of $10,000 to set on foot research regarding the production of silk, to the end that the money now paid to foreign labor be distributed at home.

*STANDARD METHODS OF WATER ANALYSIS.**

As its first report of progress, the Committee on Standard Methods of Water Analysis presents the results of a careful inquiry into the present status of this general subject. This step was deemed necessary in order to bring to the Committee needed information for its guidance in its future plans of action.

About 125 copies of a circular letter, with an accompanying list of questions, were sent to leading workers. The number of detailed replies was fewer than should have been the case. Nevertheless, these replies, with the knowledge which the members of this Committee have as to the methods used in the more prominent laboratories, enable us to present a substantially correct *résumé* of existing conditions, as given in the following pages.

Collection of Samples.—Upon the subject of collection of samples the replies to the question sent to various workers were practically unanimous, and may be summarized as follows:

Bottles for chemical samples should have a capacity of one gallon, should be made of clear white glass in order to facilitate inspection, and should have glass stoppers. They should be washed each time before use with sulphuric acid and potassium bichromate, or with alkaline permanganate, followed by sulphuric acid; they should then be thoroughly rinsed and drained. For shipment the stoppers and necks of the bottles should be protected with cloth tied over them. They should be packed in cases with separate compartments for each bottle, and lined with indented fiber paper, felt or some similar substance, or provided with

* Report presented at the Indianapolis meeting of the American Public Health Association by a committee comprising Mr. George W. Fuller, chairman; Mr. George C. Whipple, secretary; Mr. Harry W. Clark, Dr. Adolph Gehrmann, Dr. Wyatt Johnston, Dr. E. O. Jordan and Dr. H. L. Russell.

corner spring strips to prevent breaking. The packing boxes should be covered and provided with suitable fastenings.

Bottles for microscopical samples should have a capacity of at least one quart, and should be of clear white glass, but they need not have glass stoppers. Bottles for bacterial samples should have a capacity of at least four ounces and should have wide mouths and glass stoppers. Before use they should be washed as described above, and then sterilized with dry heat for one hour at 160 degrees C., or in an autoclav at 115 degrees C. for fifteen minutes. For transportation they should be wrapped in sterilized cloth, or the neck should be covered with tinfoil and the bottles put in a tin box. When bacterial samples must of necessity stand for more than twelve hours before plating, it is preferable to use larger bottles than four ounces. The gallon bottle used for the chemical sample may be sterilized and used for the entire analysis. When samples are not plated at the time of collection, they should be kept on ice at not less than 10 degrees C. Portable ice-boxes with separate compartments for the ice and bottles may be sent by express with satisfactory results.

The allowable time that may elapse between the collection of a sample and the beginning of its analysis cannot be stated definitely, as it depends upon the character of the sample and other conditions, but the following limits are generally safe:

Chemical analysis.—For fairly pure surface waters, 24 to 48 hours; and for normal ground water, 48 to 72 hours. Polluted water requires analysis within twelve hours.

Microscopical examination.—For fairly pure waters, 24 hours. If fragile organisms, such as Uroglena, Synura, etc., are present, immediate examination may be necessary.

Bacteriological examination.—Immediate plating is always best, but seldom practicable. With fairly pure waters packed in ice, plating within 12 hours after collection will not introduce errors sufficient to vitiate the results.

Physical Examination.—The physical examination includes observations of the temperature, general appearance, color, turbidity and the odor in hot and cold samples.

The temperature should be taken at the time of collection, and expressed, preferably Centigrade degrees, to the nearest 0.5 degree. For obtaining temperature of water at various depths the thermophone gives the most accurate results.

The general appearance of the water should be determined by inspection in strong light after standing several hours. Substances remaining in suspension are then classed as 'turbidity on standing,' and substances settling to the bottom, as 'sediment.' The terms, none, very slight, slight, distinct, decided, etc., may be used for general work as described in the reports of the Massachusetts State Board of Health Where methods are used for expressing the turbidity and suspended matters numerically, as is necessary with sewage and some waters in some lines of work, the description of appearance may be omitted.

At the present time there is no uniformity in the methods of measuring turbidity or suspended matter. The wire method, the disk method, the diaphanometer method, the gravimetric method, and the use of standards of comparison all appear to have their field of usefulness. It is desirable that some system should be adopted for making the results by the various methods comparable, at least for those lines of work of the same general nature. In the absence of the necessary experimental data, your Committee is unable to make a definite recommendation at present, although studies now in hand will probably make this possible another year.

For measuring the amount of dissolved coloring matter in waters, the platinum-cobalt scale appears to be very generally used, although the Nessler and natural water standards and other methods are being used in important work. While the platinum standard does not appear to be wholly satisfactory, especially for very dark-colored waters, it appears to be generally suitable for ordinary use and serves well as a basis of comparison for all results. Your committee recommends that whenever any other method is used for color measurement, the relation of this method to the platinum standard shall be indicated. In the case of waters which are appreciably turbid, the suspended matters should be removed before determining the color which relates strictly to soluble matters.

The odor should be observed in both hot and cold samples, and the results recorded in terms expressing quality and intensity, substantially as described in the paper on this subject presented to this Section last year. (*Transactions* A. P. H. A., 1899, p. 587.)

Microscopical Examination.—The modified Sedgwick-Rafter method appears to give general satisfaction. The majority of analysts express the results in 'Number of Organisms per Cubic Centimeter,' but those who have had the largest experience with the method prefer to express the results in 'Number of Standard Units per Cubic Centimeter.' Inasmuch as the latter method takes into account the size of the various organisms, and may also be used for the amorphous matter, your Committee favors the general adoption of the standard unit method.

Chemical Analysis.—So far as your Committee has been able to learn, the chemical methods used for an ordinary sanitary analysis of a water do not vary very materially in those laboratories where most of this work is now being done. As a rule, the differences which are found appear to be justified by the differences in the nature of the waters and the objects of the work. It appears, however, from general observation, that there is room for improvement in a number of laboratories in which water analyses are made in small numbers and at irregular intervals. The determinations which from general opinion are considered necessary for a satisfactory sanitary analysis of an ordinary water are as follows: residue on evaporation, total and dissolved, with the loss on ignition in some instances; nitrogen as albuminoid and free ammonia, nitrites and nitrates; oxygen consumed; chlorine, and hardness. The general consensus of opinion regarding these determinations is quite harmonious on the whole, and the best current practice may be outlined in brief terms as given beyond.

Within the past few years water analysts have had occasion to study types of water about which very little was known a few years ago, and to assist in a variety of special problems relative to water pollution and various processes for the purification of both water and sewage. Such investigations have naturally resulted in an increase in our knowledge concerning a number of analytical matters, about which there was comparatively little known, in practical terms, in this country, a dozen years ago. Among the analytical methods relative to these studies, of a more or less special nature, may be mentioned those for alkalinity, iron, sulphuric acid, carbonic acid and dissolved oxygen. While the methods for these and other determinations have been carefully worked out with reference to certain conditions and waters of certain types, it is felt by the Committee that there are a number of details which can to advantage be left in abeyance until another year. The general trend relative to these so-called special methods is outlined briefly beyond.

With regard to the limits of accuracy of the several methods under various conditions, the determinations which can be best applied to various problems, the expression of the results of analysis and the interpretation of their results are all matters upon which the Committee has nothing to say until a further expression of experience and views is received from members of the Section.

Residue on Evaporation.—The amount of water used should be preferably such that the residue will weigh from three to twelve milligrams, although with sewages a greater weight is allowable. Experience alone can indicate the volume of water to be taken. Relative to dissolved residue, the suspended matter can be satisfactorily removed from surface waters of the glacial drift formation and from sewages by filtration through filter paper. The sub-microscopic clay particles of the Southern and Western waters can be best removed by a small Pasteur filter. This is not wholly satisfactory, as in some instances dissolved matters are absorbed by the filter, and in other cases they are removed from those stored in the filter. On an average it yields fair results, and no improvement can be suggested at this time.

With regard to the use of sodium carbonate, practice varies, but it would seem to be wise to add it (with a deduction from total weight) in those waters and sewages in which it is of value to obtain the loss on ignition. Evaporation is almost invariably obtained in a steam bath at a temperature of nearly 100 degrees C. The loss on ignition, it is believed, can be secured best with the use of a radiator in accordance with Drown's suggestions, although this device is not in general use. In fact, there is a growing tendency among workers to omit this determination, except for sewages and those waters relatively high in organic matter.

Chlorine.—This is determined always by titration with a standard solution of silver nitrate, using potassium chromate as an indicator. Colored surface waters first require decolorization by the addition of aluminum hydrate. The volume of water to be taken depends, of course, upon the amount of chlorides present. With unpolluted surface waters in the East, from 200 to 250 cubic centimeters should be concentrated by evaporation. In the case of sewages and highly polluted water containing much organic matter, satisfactory results can be obtained by evaporation to dryness, ignition of the residue and subsequent solution of the chlorides with hot, distilled water. The titration should be regularly made with volumes substantially the same as employed in the standardization of solutions.

Nitrogen as Free and Albuminoid Ammonia.—The volume of ordinary water taken for distillation is 500 cubic centimeters, and with very highly polluted waters or sewages smaller quantities are taken and diluted to the above amount with ammonia-free distilled water. Where many sewages are analyzed the volume taken may be 10 cubic centimeters or less, in accordance with Hazen's method. As a general rule, it seems advisable to add a few drops of a saturated solution of sodium carbonate before distillation. It is advisable to collect the distillate in the Nessler tubes in which this color is to be read. The rate of distillation should be 50 cubic centimeters in 5 or 6 minutes. It is an almost universal custom to collect three tubes of 50 cubic centimeters each, for the free ammonia, and five tubes for the albuminoid ammonia. In regard to the preparation of alkaline permanganate and Nessler solutions, the directions in any good text-book may be followed, and the individuality of various workers in these particulars is apparently not a factor affecting unfavorably the accuracy of results. Both the distillates and the standard ammonia solutions should be of the same temperature before the addition of the Nessler solution.

Nitrogen as Nitrites.—No method superior to the Warrington modification of the Gness method is now known (see page 527, Special Report, Mass. State Board of Health, 1890, Part II.).

Nitrogen as Nitrates.—The determination of nitrogen as nitrates is made almost exclusively by two methods, the phenol-sulphonic acid method of Grandval and Lajoux, and the aluminum reduction method. With waters comparatively high in nitrates, and if a good brand of nitrogen-free caustic soda can be obtained, the aluminum method is more easily worked, and gives better average results. With waters low in nitrates aud low in chlorine, the phenol-sulphonic acid method gives as good or better results than the reduction method. It is intended to consider the comparative merits of the two methods in detail in the later report.

Oxygen Consumed.—Practice varies widely both here and abroad with reference to the method for this determination; and many analysts omit it from the analyses of certain types of water. For sewages and those waters which are high in organic matter it undoubtedly yields valuable information. It would appear advisable to adopt a uniform procedure intermediate between the wide extremes now practiced. Such would be afforded by the addition of the reagents to the water when cold, and boiling for five minutes.

Hardness.—For ordinary sanitary work the soap method is commonly used, and for the soft Eastern waters it appears to give reasonably satisfactory results. For the hard waters of the West, Hehner's acid method is preferred. There are some details connected with the determination of the permanent hardness by the Hehner method which require further study.

Alkalinity.—This determination can be satisfactorily made by Hehner's method. Methyl orange is used by some workers as an indicator, while recent comparative studies give the preference to lacmoid or erythrosine. The latter indicators have the advantage, in connection with the use of coagulants, of affording the most reliable test for the presence of undecomposed alum in water.

Relative to the latter point, the logwood test is considered satisfactory by some workers, while by others it seems to be more of a qualitative test than a quantitative one. The differences in opinion are very likely due to unappreciated differences in manipulation which require further study.

Iron.—There are evidently several methods of an allied nature which can be used successfully for this determination, provided they are carefully applied. In another report the Committee can probably give a graded set of procedures, applicable to various conditions of practice. Thompson's method as described in Sutton's 'Volumetric Analysis' appears to be most generally used.

Sulphuric Acid.—Wildenstein's method as described by Ohlmuller has proved very satisfactory for certain lines of work, and preferable to the gravimetric method. Whether or not this is true under a wide range of conditions remains to be seen.

Carbonic Acid.—For Eastern waters Pettenkofer's method as described by Sutton is considered to be generally satisfactory; while for the Western waters Trillich's modification of this method, as described by Ohlmuller, is preferred by some workers. This method gives both the free and half-combined carbonic acid. There is a growing tendency among chemists to attach the more importance to the free carbonic acid alone. This can be obtained differentially by the method by which the free carbonic acid is removed, by the passage of the water through a tube containing small gravel stones, with a current of air drawn in the opposite direction. Further study of this entire subject will place it on a more substantial basis.

Dissolved Oxygen.—There appear to be several methods which can be used successfully for this determination. The method in most general use, however, is that of Winkler as described in the Special Report of the Massachusetts State Board of Health, 1890, Part I.

By way of general comment it may be added that recent developments in sewage purification have indicated the desirability of special attention to several matters. Among them is the advantage coming from a more general use of the determination of suspended matters in sewage, with the loss on ignition. Another point is the desirability of determining the organic nitrogen in unpurified sewage by the Kjeldahl method, in view of the varying percentage of this constituent which is afforded by the albuminoid ammonia. The so-called 'incubation test' to show the relation to putrefaction of sewage after purification seems to have much practical value, under certain conditions, although the details cannot be considered at this time.

Quantitative Bacterial Examinations.—With reference to this subject, there has recently been a marked improvement in the general results obtained in this country. It is true, however, that methods of different workers are still variable to a degree which seems unnecessary, and which is certainly not desirable, when we consider that the value of this class of data relates largely to purposes of comparison.

The culture medium now in general use is nutrient gelatine, prepared substantially as recommended by the Bacteriological Committee in their Report of 1897. Meat extract, however, is still used by a number of workers, in place of meat infusion. Data are lacking to justify this as a general procedure. For some special lines of work nutrient agar is used with apparent advantage. These conditions refer to analyses of decomposed or stale sewage, where the number of bacteria capable of rapid liquefaction of gelatine is very large; and also to certain lines of field work. Several investigators have tried media of modified composition, containing new ingredients in some instances, but the present evidence is altogether too inconsistent and indefinite to permit of any recommendations along this line.

Concerning the reaction of the nutrient gelatine, the optimum varies under different conditions. Speaking in general terms, the majority of waters now studied appear to require ordinarily about 1.0 per cent. acid. There are some waters for which this reaction is too acid, and the sewage of some manufacturing cities evidently requires an alkaline medium. For important continuous work the reaction to be used should be carefully worked out with reference to the local conditions.

The amount of agitation which the sample of water should receive before plating, in order to insure mixing and a separation to a reasonable degree of groups of bacteria, is afforded by 25 vigorous shakes of the partially filled sample bottle.

Most workers arrange, so far as practicable, to have not more than about 200 colonies on the ordinary plate, such as Petri dishes having a diameter of about 4 inches. For those waters in which such numbers of Bacteria are contained in small fractions of one cubic centimeter, it is the general practice to dilute them with sterilized water, rather than to use pipettes delivering small fractions of one cubic centimeter.

The amount of nutrient gelatine used for each plate ranges at different laboratories from 5 to 10 cubic centimeters. Most workers use more than 7, while in some of the largest laboratories the quantity is 5 cubic centimeters. For results to be obtained after four or more days of cultivation, the larger quantity is doubtless preferable. For results to be obtained after two days' growth, 5 cubic centimeters are found to be more satisfactory.

Practice varies with reference to mixing the water and the gelatine in the tube or on the dish, in those cases where Petri dishes are used. There is no evidence to indicate that this is a point of much practical significance, affecting results beyond the ordinary limits of accuracy.

With regard to standard conditions of cultivation, the best available evidence shows that it should take place in the dark and in an atmosphere in which moisture and oxygen are always present. Petri dishes sometimes fit too tightly to give satisfactory results, and special attention is necessary to these particulars. The temperature of cultivation should be uniformly 20 degrees C., and it is gratifying to note that in many laboratories this standard has been adopted, notwithstanding the care and expense which it sometimes involves.

The period of cultivation still varies considerably in the different laboratories. There is a well-defined movement, however, toward shorter periods in order to secure greater practical value for the data. These practical advantages outweigh the smaller numbers obtained from a shorter period, especially as all results have only a relative and not an absolute value. In Germany 48 hours is the standard period of cultivation, and daily results have been obtained on this basis from each of 26 water purification plants in operation in that country. There seems to be no good reason why the bacterial results to be obtained from the various water purification plants now in operation and about to be built in this country should not be comparable with those obtained abroad. This is especially true in view of the growing appreciation of the fact that the residual numbers of bacteria in a filtered water should receive attention as well as the percentage of bacterial removal. Taking everything into consideration, it would appear to your Committee to be advisable to adopt 48 hours as a standard period of cultivation under the conditions noted above. Before making a final recommendation there is requested a further expression of opinion on the part of the members of the Section of Bacteriology and Chemistry.

Relative to the records of the numbers of bacteria per cubic centimeter, there are many workers whose custom is very loose and unscientific. Your Committee disapproves of customs which indicate a fictitious accuracy in current methods, by the inexcusable use of significant figures in the units place where the numbers are very high.

Differentiation and Classification of Species of Bacteria.—This branch of bacteriology is of much importance in connection with water analysis, because reliable and readily available methods for the detection of waterborne disease germs cannot be established until this general subject has been placed upon a more scientific and substantial basis. It is true, of course, that progress for a time along this line must be largely a matter of pure science, and that interest in these developments is shared not only among water analysts, but all workers in applied bacteriology.

Your Committee has made every reasonable effort to secure a consensus of opinion as to how this subject now stands, with reference to the soundness or weakness of the various current methods and procedures. While the views of a number of prominent workers, especially those not directly connected with water analysis, have not yet come to hand, it is believed that the general status of affairs may be correctly outlined as follows :

It is now universally recognized that the first requisite toward successful work in this field is the use of culture media of uniform standard composition. With the view to the accomplishment of this end, the methods of preparation of media recommended by the Bacteriological Committee in their Report of 1897 are in general use. Taken as a whole, they seem to have given, and to still give, general satisfaction. It is true, however, that in several laboratories these recommendations are departed from with regard to the manipulations which apparently affect but little the question of uniformity. Practice, furthermore, varies somewhat in a number of laboratories, with reference to the use of meat infusion as compared with meat extract; in the preparation of milk for a culture medium; and in the reaction of various media for species work. Each of these points requires attention.

Concerning those tests and procedures to be employed in order to secure diagnostic data in species work, it is plain that the recommendations of 1897 have caused material advances over previous methods. It is certain, however, that the 1897 Report in this respect has thus far met less support and approval than in the case of the preparation of culture media. The report has evidently set at work a leavening process in several places, and an improved state of affairs will presumably result in time. Why it is that with test after test there is a disagreement as to value among experienced workers is a matter which is not now understood, and which suggests unappreciated differences in procedures.

Relative to the results of those tests which are considered to be of differential value, and to the method of recording them, opinion is widely at variance. Some believe that they should be confined to those of a positive and definite nature. Other workers consider that they cannot be made too detailed and exhaustive.

In brief terms it may be said that, with regard to the general subject of species differentiation, a material step in advance has been taken in consequence of the Report of the Bacteriological Committee of 1897. As a result of the added knowledge coming to various workers through the general use of the 1897 Report as a guide, the time has arrived when that Report can and should be revised. Concerning the new evidence which has been obtained since that Report was prepared, it has not yet reached your Committee in a form adequate to allow changes to be recommended at this time. In fact, there are many indications which go to show that the amount of directly comparable evidence from the various laboratories is much less than is generally realized, owing to the wide variety in the nature of the species work now going on in this country.

In the opinion of your Committee the real issue for discussion to-day on this topic is not the question of detailed points of improvement, but rather the best general procedure by which species work can be elevated to a higher plane of excellence. This matter has received considerable thought from the Committee, and it would appear that as a first requisite it will be necessary to secure the cooperation of the workers in other branches of bacteriology. It would also appear to be necessary to secure comparable data upon corresponding cultures of the same species from a considerable number of experienced workers. Further, it would be very desirable if data from the same species could be obtained at the same laboratory with culture media prepared by a number of other investigators.

Fermentation Tests and the Detection of B. coli communis and other Specific Forms.—While these methods come within the scope of general species methods for bacteria, it is considered that they are entitled to separate consideration. This is due to the fact that this subject is studied by many water analysts who do not attempt general species determinations, and to the further fact that upon these topics opinion is more crystallized than upon the general subject of species methods.

Relative to fermentation tests, this topic was considered at length by the Bacteriological Committee in the Report of 1897. The present status with reference to those recommendations may be outlined as follows:

In the preparation of fermentation solutions, the use of meat infusion as compared with meat extract is still an open question. Both are used. Opinion seems unanimous, however, that in either case they should contain no muscle sugar. It is generally considered that a reaction of 1.5 per cent. acid is not perfectly satisfactory, and most workers employ solutions which are practically neutral to phenolphthalein. The amount of sugar is 1 per cent. as a rule, as recommended, although it appears that glucose is used by many to the exclusion of lactose and saccharose. This latter tendency would seem to be a step in the wrong direction, for many lines of work. Opinion is at variance concerning the effect of heat upon these sugars in the course of the preparation of the solutions. Cultivations are made almost invariably at 37 degrees C. for a period of three days, with records daily as to the percentage of gas in the closed arm. In other particulars there are some differences in general practice, but they apparently are of little consequence in affecting results such as would be obtained by strict adherence to the procedures of the 1897 Report.

While considerable increase to our knowledge of the fermentation-produced bacteria has occurred within the past three years, there is not at present sufficient evidence at hand to recommend an improved set of procedures.

With regard to the isolation of *B. coli communis*, there are evidently quite a number of procedures which are used with success. These procedures differ somewhat on account of the wide range in natural conditions under which tests are made for this form in various waters. Where *B. coli communis* forms a small percentage of the total bacteria, the custom appears to have come into general use of employing a preliminary incubation to eliminate ordinary water bacteria. It is thought that it will not be a laborious task during the coming year to draft a graded series of acceptable methods to cover the wide range of conditions met with in practice.

It is gratifying to note a general uniformity in the characteristics considered essential to the identification of *B. coli communis*, as follows:

1. Fermentation of dextrose with the production of carbonic acid equal approximately to 33 per cent. of the total gas formed.

2. Coagulation of milk.

3. Non-liquefaction of gelatine, with growth at the surface and in the form of beads along the line of inoculation in a gelatine tube-culture.

4. Formation of indol.

5. Conformity to the main morphological characteristics of this type as published.

With reference to those forms resembling *B. coli communis*, which ferment sugars with the production of carbonic acid varying widely from 33 per cent. of the total gas, it is now generally regarded that they should not be reported as *B. coli*. What their true relation is to this species, and what their sanitary significance is relative to the character of waters in which they are found, are questions which cannot be answered satisfactorily at present.

Very few, if any, experienced bacteriologists engaged in public health work make a practice of attempting to isolate the typhoid bacillus or any specific forms other than *B. coli communis*. For obvious reasons it is inadvisable at this time to give this phase of water analysis any detailed consideration.

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*SUNSPOTS AND RAINFALL.**

At the meeting of the Royal Society on November 22d, Sir Norman Lockyer and Dr. W. J. S. Lockyer presented a paper on 'Solar Changes of Temperature and Variations in Rainfall in the Region Surrounding the Indian Ocean.'

Sir Norman Lockyer, who made the communication, said the fact that the abnormal behavior of the widened lines in the spectra of sunspots since 1894 had been accompanied by irregularities in the rainfall of India, suggested the study and correlation of various series of facts that might be expected to throw light on the matter. Among the conclusions thus arrived at were: (1) A discussion of the chemical origin of lines most widened in sunspots at periods of *maxima* and *minima* indicated a considerable rise above the mean temperature of the sun around the years of sunspot *maximum* and a considerable fall around those of sunspot *minimum*. (2) From the facts of rainfall in India (during the southwest monsoon) and Mauritius between the years 1877 and 1886, as given by Blanford and Meldrum, the effects of these solar changes were seen to be felt in India at sunspot *maximum* and in Mauritius at sunspot *minimum*, the greater effect being in Mauritius. The pulse in Mauritius at sunspot *minimum* was also felt in India, giving rise generally to a secondary *maximum*. India, therefore, had two pulses of rainfall, one near the *maximum* and the other near the *minimum* of the sunspot period. (3) The dates of the beginning of these two pulses in the Indian and Mauritius rainfall were related to the sudden remarkable changes in the behavior of the widened lines. (4) All the famines recorded in the Famine Commission reports as having devastated India during the last half-century occurred in the intervals between these two pulses. (5) Investigation of the changes in (*a*) the widened lines (*b*) the rainfall of India, and (*c*) the rainfall of Mauritius during and after the last *maximum* in 1893 showed in all three important variations from those exhibited during and after the last *maximum* of 1883. The *minimum* of 1888–89 resembled the preceding *minimum* of 1878–79. (6) From 1849–1878 the lowest Niles recorded occurred between the same intervals. (7) Although the relations of these intervals to the droughts of Australia and of Cape Colony, and to the variations of rainfall in extra-tropical regions generally, had not been investigated, a general agreement had been made out between the intervals and the rainfall of Scotland, and both pulses had been traced in the rainfalls of Cordoba and the Cape of Good Hope. (8) The results of the inquiry having been placed before Mr. John Eliot, Meteorological Reporter to the Indian Government, he gave it as his opinion that they accorded closely with all the known facts of the large abnormal features of the temperature, pressure, and rainfall in India during the last twenty-five years, and that hence the inductions already arrived at would be of great service in forecasting future droughts in India.

When the image of a sunspot was thrown on the slit of a spectroscope, examination of the spectrum indicated that the blackness of the spot was due not only to general but also to selective absorption, and that the lines widened by the selective absorption varied from time to time. From many years' observations of these widened lines it appeared that at some periods they were distinctly traceable to known elements, while at others their origins had not been

* From the London *Times*.

discovered and they were classed as unknown lines. Comparison of these two periods, with the sunspot curve as constructed from the measurements of the mean spotted area for each year, indicated that when that area was greatest the widened lines belonged to the unknown class, but when it was least to the known class. Now, in the laboratory it was possible to differentiate between three stages of temperature—that of the flame, of the electric arc and of the electric spark of the highest tension. At the lowest temperature—that of the flame—a certain set of lines was obtained; as the temperature of the arc was reached a new set was seen; and at the temperature of the high tension spark other lines, called enhanced lines, were added, while many of the arc lines waned in intensity. At sunspot *minimum*, when the known lines were most numerous, the lines were almost invariably those seen most prominently in the arc. But as the *minimum* passed towards the *maximum* the unknown lines gradually obtained the predominance, and these were possibly 'enhanced' lines, indicating the action of a much higher temperature on known substances. It was therefore justifiable to assume a great increase of temperature at the sunspot *maximum* where these unknown lines appeared. The curves of the known and the unknown lines had been obtained by determining for each quarter of a year the percentage numbers of the two kinds, and plotting them as ordinates with the time elements as abscissæ. But for the purposes of the investigation, instead of using the mean curves of all the known elements involved, that for iron alone was employed, since that metal was a good representative of the known elements, and had been most fully studied. Such curves when drawn crossed each other at points where the percentage of unknown lines was increasing and that of iron or known lines decreasing, and *vice versa*. There seemed, therefore, to be three well-marked stages of solar temperature. At the crossing points, where the numbers of known and unknown lines were about equal, a mean condition might be assumed, a *plus* pulse or condition of temperature being indicated when the unknown lines reached their *maximum*, and a *minus* pulse when the known ones reached their *maximum*. The curves obtained during the last 20 years endorsed the conclusion that the unknown lines curve varied directly and the iron-lines curve inversely with the sunspot area. The widened-line curves were quite different from those furnished by the sunspots. The crossings were sharply marked, and since 1879 three of them had occurred, indicating the presence of mean solar temperature conditions in 1881, 1886-87, and 1892; another such crossing was anticipated in 1897, but has not as yet taken place. Sunspots were indications of excess, not of defect, of heat, and it was now known that the spots at *maximum* were really full of highly heated vapors produced by the prominences, which were most numerous when the solar atmosphere was most disturbed. The Indian meteorologists had abundantly proved that the increased radiation from the sun on the upper air currents at *maximum* was accompanied by a lower temperature in the lower strata, and that with this disturbance of the normal temperature pressure changes must be expected. Chambers was the first to show that large spotted area was accompanied by low pressures over the land surface of India. To pass from the consideration of individual spots to the zones of prominences with which they were probably associated, it was of the highest interest to note the solar latitudes occupied when the crossings already referred to took place, as in this way were discovered the belts of prominences which were really effective in producing the increased radiation. The area of these being much larger a considerable difference of radiation might be expected —a fact it was all the more necessary to point out, because the insignificance of the area occupied by the spots had been used as an argument against any easily recognized connection between solar and terrestrial meteorological changes. Assuming two belts of prominences north and south 10° wide, with their centers over latitude 16°, one-sixth of the sun's visible hemisphere would be in a state of disturbance.

The authors' object in studying rainfall was to ascertain whether the *plus* and *minus* temperature pulses in the sun were echoed by *plus* and *minus* pulses of rainfall on the earth. The rainfall tables published by the Indian Government were first studied with special reference to the southwest monsoon, and it soon became evident that in many parts of India the *plus* and *minus* conditions of solar temperature were accompanied by *plus* and *minus* pulses producing pressure changes and heavy rains in the Indian Ocean and surrounding land. These occurred generally in the first year following the mean condition—viz., in 1877–78 and 1882–83, dates approximating to, but followed by, the *maximum* and *minimum* periods of sunspots. It was especially in regions such as Malabar and Konkan, where the monsoon struck the west coast of India, that the sharpness and individuality of these pulses were the most obvious. The study of Eliot's table of the rainfall of all India from 1875 to 1896 revealed predominant pulses in 1889 and 1893, following those of 1877–78 and 1882–83, so that it enabled the working of the same law—of the mean solar temperature being followed by a pulse of rainfall—to be traced through another sunspot cycle. The 'whole India' curve between 1875 and 1896 was also used to test whether the sun pulses, which were found to be bound up with the Indian rainfall, were in any way related to the variatious often pointed out in the snowfall on the Himalayas; it was found that the values occurring at the *plus* and *minus* pulses were among the highest. Hence it appeared that the quantity both of rain and snow was increased in the years of the rise both of the unknown and of the iron lines. For the Mauritius the rainfall curve, plotted from 1877 to 1886, was seen to be fairly regular, showing alternately an excess and a deficiency of rainfall. The highest points of the curve were reached in 1877 and 1882, the lowest in 1880 and 1886. Thus the *maximum* rainfall of 1877 occupied about a year after the rise of the known lines in 1876, while the next pulse of rainfall in 1882 followed the succeeding crossing when the unknown lines were going up, also about a year later. The curves expressing the rainfall for the Cape and Cordoba for the same period showed two prominent *maxima* in the years 1878 and 1883, corresponding nearly with the *plus* and *minus* pulses of solar temperature. On comparing them also with the Bombay and Mauritius curves for the same period, it was found that the pulses indicated at Bombay occurred simultaneously with those of 1878 and 1883, but in Mauritius the effect of each of the pulses was felt a year or so earlier—namely in 1877 and 1882. The rainfall curve for Batavia for this period had its prominent *maximum* in 1882, as in Mauritius, thus preceding by a year the pulse felt at the Cape, Cordoba and Bombay in 1883.

Unless the pulses either overlapped or became continuous, there would obviously be intervals between the ending of one and the beginning of another. The *plus* and *minus* pulses, to which attention had chiefly been directed, were limited in duration, and when they ceased the quantity of water falling in the Indian area was not sufficient without water storage for the purposes of agriculture. They were followed, therefore, by droughts, and subsequently, at times by famines. Thus, taking the period from 1877 to 1889, there was rain from the *minus* pulse in 1877–78–79 (part); no rain pulse in 1879 (part)–80–81 (part); rain from *plus* pulse 1881 (part) 82–83–84 (part); no rain pulse in 1884 (part)–86–87; and rain from the *minus* pulse in 1887 (part)–88–89. All the Indian famines since 1836 had occurred in these intervals, carried back in time on the assumption of an 11-year cycle. Thus, taking 1880 as the central year on the ascending curve, it was itself a year of famine in Madras and the North-West Provinces; also

1880 — 11 = 1869, N.W.P. famine (1868–69)
1869 — 11 = 1858, N.W.P. famine (1860)
1858 — 11 = 1847,
1847 — 11 = 1836, Great famine in Upper India (1837–38). Again, taking 1885–1886 as the central years on the descending curve :—

1885–86, Bengal and Madras famines (1884–85)
(1885–86)—11=1874–75, N. W. P. famine (1873–74) Bombay famine (1875–76) Bombay and Upper India famines (1876–77)
(1874–75) — 11 = 1863–64, Madras and Orissa famines (1865–66)
(1863–64) — 11 = 1852–53, Madras famine (1854).

It was clear from this table that if as much had been known in 1836 as was known now, the probability of famines at all the subsequent dates indicated might have been foreseen. The dates might also be carried forward from 1880; thus—

1880 + 11 = 1891, N.W.P. famine (1890) Madras, Bombay and Bengal famines (1891–92)
(1885–1886) + 11 = 1896–97, General famine.

Famine years in India were usually years of low flood in Egypt, and it might be pointed out that the highest Niles followed, at an interval of one or two years, the years of the *plus* and *minus* pulses. As to the great Indian famine of last year, the widened line curves, so far from having crossed in 1897 or 1898, as they ought according to the few precedents available, had not crossed even now; in other words, the condition of ordinary solar mean temperature had not even yet been reached. Now India in a normal cycle was supplied from the southern ocean during the *minimum* sunspot period, and the rain was due to some pressure effect brought about in high southern latitudes by the sun at *minus* temperature. But as this temperature condition was not reached in 1899, as it would have been in a normal year, the rain failed. Thus the only abnormal famine recorded since 1836 occurred precisely at the time when an abnormal effect of an unprecedented *maximum* of solar temperature was revealed by the study of the widened lines.

THE ULKE COLLECTION OF COLEOPTERA.

The collection of Coleoptera brought together during the last 50 years by Henry Ulke, of Washington, D. C., has been purchased by the Carnegie Museum, of Pittsburgh, Pa.

Henry Ulke, artist, musician, entomologist—a noticeable character from many points of view—having passed beyond his eightieth birthday, has given up his entomological collections, but by no means his interest in this branch of science. The writer met him the other day in Washington, active, alert, clear-eyed, with a complexion like a child's, and asked him how it was that he retained his youth at 10 years beyond the allotted space of life. The reply was wittily characteristic and contained a characteristic truth: "In the first place," said Ulke, "I was very careful in my choice of parents; and in the second place, my love of Nature has kept me constantly in the woods and fields throughout all my life."

The Ulke collection of Coleoptera is one of the largest and, historically and in other ways, one of the most important collections in the United States. It represents the life-long work of one of our most experienced and most assiduous collectors. Its foundation dates back nearly half a century, and up to within the past few years Mr. Ulke spared no effort to increase it by collecting or by exchanging. In the early days of the great transcontinental surveys, the Smithsonian Institution had not begun to make collections of insects, and as a result much of the material picked up by the naturalists connected with these surveys fell into Mr. Ulke's hands. He was never a publishing entomologist, and the writer believes that only one published paper bears his name. That was a report on the beetles collected by one of the Wheeler survey expeditions. The collection numbers perhaps 125,000 specimens, and its large number of species—more than 11,000—as well as the large series of specimens representing each species, rendered this collection for many years preeminent among other collections. It is, in fact, only within the past 15 or 20 years, when careful collecting methods have become more generally adopted and when railroads have made all parts of the country more accessible, that other large private collections have been formed. Ulke early appreciated the importance of large series, and at a time when other collectors were gathering beetles as a boy collects postage stamps, one or two specimens representing a species, Ulke had his long rows of specimens indicating variation within specific limit and variation due to geographic and other environmental dissimilarities.

A distinguishing feature of the collection is the uniformly perfect preservation of the specimens as well as the exquisite and painstaking care with which even the most delicate specimens are prepared and thus rendered available for study. In this respect the collection is still unapproached by any other.

How much the progress of North American coleopterology is indebted to this collection can readily be seen from the writings of systematists, and in fact there is not a single worker in this field who has not drawn material from the Ulke collection. The liberality with which Mr. Ulke has always placed his collection at the disposal of students and workers is well known and has been acknowledged in print over and over again. The collection was employed by Le Conte and by Horn in the preparation of their various monographs and revisions, and has been similarly used by Dietz, Hayward, Matthews and others. That the collection has thereby been increased in scientific value goes without saying and besides a large number of actual types the collection contains several thousand specimens which are cotypical in value.

The Carnegie Museum, at Pittsburgh, already contains the collection of Coleoptera of the late Dr. John Hamilton, and it is sincerely to be congratulated upon this last important addition to its entomological treasures. This is the first time, I believe, that a private collection made in our Eastern States finds its way west of the Allegheny Mountains, and while the writer sincerely regrets that the collection could not remain in Washington as the property of the U. S. National Museum, he feels consolation in the firm conviction that it will be well cared for at Pittsburgh, at least so long as Dr. Holland remains Director of the Carnegie Museum (and may that be for many years to come!), and will continue to to be a source of information and study for the younger generation of coleopterists.

The Museum also contains, as is well known, the superb collection of Lepidoptera brought together by Dr. Holland, and this last collection cannot fail to place the Carnegie Museum in a group of four public institutions which contain collections of insects of great extent and value and which will be consulted by students for generations to come. The other three great collections are to be found at the Museum of Comparative Zoology, at Cambridge, Mass.; the Academy of Natural Sciences, at Philadelphia, Pa.; and the U. S. National Museum, Washington, D. C.

L. O. HOWARD.

SCIENTIFIC BOOKS.

American Hydroids, Part I, The Plumularidæ. By C. C. NUTTING. Washington, 1900. Published by the Smithsonian Institution. Pp. 285; pls. 34.

We are accustomed to think of social life and the division of labor as being especially characteristic of highly organized beings, such as ourselves among the vertebrates, and the ants among the arthropods; but as a matter of fact socialism was invented and put into practice very early in the history of terrestrial life, among creatures not so very far removed from the most primitive types known to us. Professor Nutting, in the splendid monograph now under review, tells us (p. 46) that "Hydroids are exceedingly low in their organization and exhibit in several respects the appearance of loosely aggregated assemblages of cells which are individually much like protozoa," and yet he describes and figures the wonderfully differentiated individuals or 'persons' which make up the beautiful and complicated feather-like colonies of these animals. That there would be some differentiation for reproductive ends we might well expect, but the Plumularidæ keep a standing army of remarkably constituted individuals, supported by the common purse, and fighting for the common weal. Listen here to Professor Nutting:

"As to the morphological significance of the sarcostyles, all of the more recent authorities, except Jickeli, regard them as degenerate individuals of the colony, or as 'fighting persons.' That they are individuals or 'persons' is a matter hardly admitting of doubt; but it may well be questioned whether they are *degenerate* persons or not, and an argument might be constructed which would go to show that instead of being degenerate individuals they are in fact very highly specialized persons. Specialization is indicated when the structure has departed from the original type in order to become adapted to more definite and exclusive function. It would seem that the sarcostyles have done this very thing—departed from the original type (*Protohydra?*), and become morphologically differentiated into individuals having the definite function of defense, in most cases, and of prehension by means of adhesive cells in others" (p. 28).

All of which teaches us that, after all, living protoplasm is *the* wonderful thing; granting it, the varied and complicated manifestations of life may be said to follow naturally and inevitably, their extent and variety dependent on warmth and moisture, time and space, but their essential nature what it was when life first appeared upon the earth.

These things may sound trite; but while we talk glibly of differentiation and evolution, we do not always descend from the abstract to the concrete, and realize the actual facts. Professor Nutting's monograph should have this value to the general zoologist and the teacher of science, that it brings them as nearly into contact with the things themselves and their way of life as may be possible without a prolonged and special study of the group. The study of types may give us a certain knowledge of structure, but without a real insight into life-histories, we miss most of the fun, and may therefore be thankful to be invited to partake of the provender so laboriously gathered for our benefit.

In 1862, the elder Agassiz recognized only three Plumularidæ from the coasts of the United States. To-day Professor Nutting makes us acquainted with 121 American species, eight of which, however, are not found north of the Isthmus of Panama. Of the 121, no less than 52 have been first made known by Professor Nutting himself. Most of the species come from the West Indies, and it seems rather remarkable that only ten are reported from the whole Pacific coast of North America. Surely more careful collecting off the coasts of Southern and Lower California should bring to light a number of new forms.

T. D. A. COCKERELL.

The Oil Chemist's Handbook. By ERASTUS HOPKINS, A.M., B.Sc., Chemist in charge of U. S. Laboratories, Boston, Mass. New York, John Wiley & Sons; London, Chapman and Hall, Limited. 1900. Pp. viii + 72.

This book is intended as a practical laboratory handbook for use in the examination of commercial oils and fats. Concise and satisfactory directions are given for the execution of the ordinary quantitative determinations which are made with materials of this class. The special and most valuable feature of the book, however, consists in the full tables which are given, and in their excellent arrangement. These include tables of general properties, solubility, adulterants and of constants. The tables of constants are duplicated by giving, first, a table arranged with reference to the oils, giving all of the important constants for each oil, and then tables for each constant, as saponification value, iodine value, Reichert-Meissl value, etc., with the oils arranged according to their numerical values for the given constant. The tables appear to have been prepared very carefully and the book is a very valuable one for those working in this field.

W. A. N.

The Calculations of Analytical Chemistry. By E. H. MILLER, Ph.D., Instructor in Analytical Chemistry and Assaying in Columbia University. New York, The Macmillan Co. 1900. Pp. 183.

As the author states in the preface: "This text-book is intended for use in scientific schools and colleges, in connection with courses in analytical chemistry, and aims to give a logical treatment of the calculations required by an analyst." "The object has been to furnish a text-book, which shall give the necessary information concerning those important chemical calculations which every student should thoroughly understand before taking up advanced work." "Formulæ have been avoided, except in the last chapters, so that the student shall consider each problem individually and solve it from a knowledge of chemical laws instead of substituting in formulæ for different cases."

The subjects taken up in this book are as follows: Calculations of chemical equivalents and atomic weights; of formulæ and percentage; of mixtures having a common constituent; calculations from equations; calculation and use of factors; calculations of volumetric analysis; of density of solids and liquids; of gases; of calorific power and electric and electrolytic calculations for direct currents. The method involved in each case is clearly explained with example, and a number of problems for solution are given in each chapter. The author has brought together here in a compact form some of the most important calculations of analytical chemistry. Much of the material would be inaccessible to a student or perhaps worked out from formulæ given without any explanation of the principles involved. A number of tables are also given of values used in the calculations.

J. E. G.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Journal of Physiology, December, has as its leading article 'The Reactions of Planarians, with and without Eyes, to Light,' by G. H. Parker and F. L. Burnett. They found that planarians without eyes tend to turn away from their course when directed towards the source of light and to keep in it when directed away from the source. This reaction, however, is less precise than in planarians with eyes. Planarians with eyes move more rapidly than those without eyes, and those moving away from the light than those moving towards it. Anne Moore contributes a paper on 'Further Evidence of the Poisonous Effects of Pure NaCl Solution.' According to her investigations pure solutions of the chlorides of Na, Ca, K, Mg, and Li are poisonous. The poisonous effects of a pure NaCl solution may be antagonized by Ca, although Ca is not necessary in itself, for it renders a sugar solution more harmful. K does not antagonize Na, but may antagonize Ca used in small quantities. In weak solutions sugar is as poisonous as isosmotic solutions of NaCl, but in stronger solutions this is not true. Young trout and tadpoles live indefinitely in distilled water, and in salt solutions if Na and Ca ions are in balanced proportions. The 'Influences of Digestion on Animal Heat Processes' are presented in a study by E. T. Reichert. He concludes that the rise of temperature during digestion (maximal about the fourth hour) is due to an increase of heat production. Since the greatest increase of heat production occurs during the first hour after feeding, the changes in heat production and temperature are not proportional. The most marked effects are produced from a proteid and fat diet, next with proteid alone, and least with fat. R. M. Yerkes continues his work on phototaxis with a study of the reactions of *Daphnia* and *Cypris*. A marked increase in rate of movement of *Daphnia* with increased intensity of light he ascribes to greater precision and quickness of orientation, and in part also to more rapid swimming. In *Cypris* this phenomenon is not so marked, a difference ascribable probably to the greater importance to *Daphnia* of orientation as a factor in rapid movement. Contact with the sides of a pipette appears to render a negative animal positive, but so far as observed the reactions do not change with changes in temperature. For the forms studied light is a sufficiently strong directive agent to lead them into fatal acid solutions.

The Journal of the Boston Society of Medical Sciences for October 23d is devoted to the important and interesting 'First Annual Report of the Cancer Investigation Committee to the Surgical Department of the Harvard Medical School.' This summarizes the investigations made during the past year through the bequest of Caroline Brewer Croft. In the 'Introduction,' by J. Collins Warren, the steady increase of cancer is noted, and the 'Statistics of Cancer,' by W. F. Whitney, show that their increase is about the same in New England and Great Britain. Edward H. Nichols gives an account of the work 'On the Etiology of Cancer,' in which he states that attempts to produce cancer in animals by inoculation with tissue from human cancer have so far uniformly failed and that no attempt to isolate an organism from human cancer has succeeded. R. B. Greenough has a 'Report on the Presence of Plimmer's Bodies in Carcinomatous Tissue,' showing that three bodies were present in each of thirteen cases. E. E. Tyzzer describes 'Tumors and Sporozoa in Fishes,' and Edwin A. Locke describes 'The Reconstruction in Wax of a Nodule of Cancer.' Oscar Richardson also has a 'Report of Culture Experiments made with Carcinomatous Tissue, 1899 and 1900,' which shows that he too was unable to obtain any trace of a specific infecting organism. The report is illustrated with a number of fine plates.

The American Naturalist for November is devoted to the invertebrates. W. M. Wheeler describes in detail 'A Singular Arachnid (*Kœnenia mirabilis* Grassi) occurring in Texas' and also 'A New Myrmecophile from the Mushroom Gardens of the Texan Leaf-cutting Ant,' to which the name of *Attaphila fungicola* is given. C. B. Davenport has a paper 'On the Variation of the Shell of *Pecten irradians* Lamarck from Long Island,' considering that those described are either self-adjustments to accidents or sports which represent typical conditions in allied species. A somewhat similar paper is that by Minnie Marie Enteman on 'Variations in the Crest of *Daphnia hyalina*,' in which the author shows that variation is confined to summer forms and that to some extent there is a local tendency to particular variations. Finally W. S. Nickerson discusses 'Double Loxosomæ,' considering that the cases noted were due to fusion and not fission.

The *Popular Science Monthly*, for November, reprints for its opening article, under the head of 'Oxygen and the Nature of Acids,' the paper 'On Dephlogisticated Air,' by Joseph Priestley and the 'Memoir on the Existence of Air in the Acid of Nitre; General Considerations on the Nature of Acids,' by Antoine Laurent Lavoisier. Simon Newcomb continues his 'Chapters on the Stars,' considering their masses and densities, gaseous constitution, and evolution. H. W. Conn discusses 'Microbes in Cheese-Making,' telling briefly what has been done and what remains to be done in the problem of cheese ripening. Under the title of 'Submarine Navigation,' W. P. Bradley gives an interesting account of the various craft that have been devised for that purpose with somewhat detailed descriptions of the *Argonaut* and *Holland*. George C. Whipple describes 'Municipal Water-Works Laboratories' showing the work that has been done by them and intimating that in the future they will play an important part. George Stuart Fullerton discusses 'Freedom and Free Will' and William Barclay Parsons treats of 'Chinese Commerce' the gist of which is a plea for what every sensible man knows should exist, a permanent consular service. There are interesting articles under the head of 'Discussion and Correspondence,' 'Scientific Literature' and 'The Progress of Science.'

Bird Lore for December comes in an enlarged form and has for its frontispiece a fine photograph from life of a rough-legged Hawk. E. R. Warren describes, with a number of illustrations, 'Photographing Ptarmigans' and this is followed by an article on 'How Ptarmigans Moult,' by Jonathan Dwight, Jr., the best authority on that vexed subject. Bradford Torrey writes of 'Winter Pensioners.' The department 'For Teachers and Students' is devoted, under the caption 'Birds and Seasons' to the first series of papers giving an outline course of bird-study for the year, the present dealing with the months of December and January and with various part of the country from Boston to San Francisco, each article being by a well known authority on the subject. The other and shorter articles under the different departments are too numerous for individual notice, but the Audubon Department is of particular interest.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting of the Section on October 15th, Dr. A. A. Julien in the chair, about thirty persons were present.

The Secretary of the Academy nominated for membership Riccardo Pattelli and Charles Lane Poor, and the names were referred to the Council.

The following notes on the results of the summer's work by members were presented:

Gilbert Van Ingen.—Paleozoic Faunas of Northwestern New Jersey.

Mr. van Ingen described the work of the party belonging to the Geological Survey of New Jersey, which, during the past two summers, has been engaged in tracing the outcrops of the paleozoic formations, and collecting fossils. Of this party, Mr. Kummel, the assistant State geologist, traces the boundaries and works out the tectonics, while Dr. Weller, of the University of Chicago, collects fossils at localities indicated by Mr. Kummel. During July, Mr. van Ingen spent a week with this party in the field at Newton. Newton is situated on the shales of the Trenton group, there extensively quarried for slates. To the east is a low ridge of limestone which presents the same appearance as the Barnegat limestone along the Hudson river. The upper part of this limestone has yielded trilobites, probably *Dikellocephalus*, indicating that this portion is of upper Cambrian age. At other localities a trilobite described by Weller as *Liostracus jerseyensis*, shows that the rock there is also Cambrian—probably of the middle or upper division. In the vicinity of Franklin Furnace good specimens of *Olenellus cf. thompsoni* were found at localities described by Foerste. Further to the east of Newton, on the other side of the Cambrian ridge, is a wide belt of Ordovician rocks—Trenton limestone overlaid by a thick series of shales. The limestone contains the typical Trenton fauna,—*Rafinesquina Plectambonites*, *Pterygometopus*, etc.,—and is very much like that found at Rosetown, Ulster Co., and Rochdale, Dutchess Co., N. Y. The shale has few fossiliferous beds, but occasionally one of the more sandy layers contains *Dalmanella testudinaria*, *Plectambonites* and *Rafinesquina*—the same combination found in the Hudson shales at Poughkeepsie and at Roundout. At one locality was found a fauna with *Ampyx* and *Harpes*. In eastern New York these genera of trilobites are found only in the Chazy limestone, and the discovery is of great interest in that it indicates the presence of this formation at a distance of almost 250 miles south of what has hitherto been recognized as its southern limit. Further to the northwest, along the Delaware river, were found the Silurian and lower Devonian formations. The finest section is seen in the face of the cliff of the old Nearpass quarry, about three miles south of Tri-States, where all the formations from the upper Ordovician to the Esopus shale of the lower Devonian appear, with numerous fossils. At Otisville the Shawangunk grit is finely exposed in a large quarry. All the evidence at hand points to the conclusion that this formation, of a thickness of at least a thousand feet, was formed as a flood plain deposit. Its characteristics, except color, are the same as the New Jersey and Connecticut valley Jurassic sandstones. Ripple-marks, sun-cracks, cross-bedding, channel-fillings, etc., are abundant. In the railroad cut west of Otisville the grit lies upon Hudson shales, with non-coincident dip. On the contact occurs a few inches of clay, which next to the shale, is quite free of pebbles, while next the grit it is filled with quartz pebbles. This was interpreted to be residual clay caused by the decomposition of the shale, through sub-aërial agencies, before it became covered by the grit. The old notions regarding rock-formation required the presence of a body of water in which the sediments might be deposited. Several of the geological subdivisions showed characters which would not have been present had these formations been laid down under water, for this mode of origin results in a sorting of the rock-forming materials, and no sorting is detected in these grits. Flood plain deposits are very irregular, both as to stratification and sorting of materials, and these features are well exhibited in the grits. Other formations that are probably plain-flood deposits are parts of the Potsdam sandstone in eastern New York, the Medina sandstone, the sandstones of the Catskill group, and many of the sandstones of the coal measures of Pennsylvania and the Mississippi valley—in fact the greater part of the 'Barren Measures.'

Dr. Theodore G. White presented notes on 'The Glen Falls, N. Y., section of the Lower Ordovician,' described his detailed study of the faunas of successive strata at Glen Falls, and their relations to similar studies along the Lake Champlain valley to the north, and the Mohawk and the Black River valleys to the west. The section forms a low anticline along the shore of the Hudson. At the base is seen the Calciferous sandrock, containing *Ophileta* and fucoids. Conformable upon this is a layer a few inches thick, of barren black shale, which is very much crushed, and then the same beds of the ostracod, *Leperditia*, and their associated corals and peculiar forms of *Strophomena*, as have been found in the lowest Black River zones on Button Island in Lake Champlain. The zones of *Parastrophia* and *Triplesia*, occurring near this portion of the series in localities to the north and west, were not found here. The succeeding coral beds of *Columnaria* were well developed. Above these are the cross bedded gray beds, which in some recent reports have been considered to represent the Birdseye limestone, which seems to be lacking in this locality, unless met with at this unexpectedly high position. The upper portion of the section, which is of lower Trenton age, shows no unusual forms. The tendency of the lowest and the uppermost portions of the Ordovician sections in the region to wear away and appear wanting, owing to their prevailing softness, was commented on.

Dr. Henry S. Washington read a paper on 'The Rocks of Lake Winnipesaukee, N. H.,' as a preliminary report on work done by Professor Pirsson and himself on Mount Belknap and Red Hill, near Lake Winnepesaukee, N. H. The rocks of Mount Belknap are shown to be prominently a quite uniform alkali syenite, which is cut by many dikes of camptonite and allied rocks, and of bostonites, aplites and syenite-porphyries. These dikes also cut the surrounding porphyritic gneiss. At one place, near the border, is a mass of basic hornblende-gabbro, with large, poikilitic phenocrysts of brown hornblende. A syenite breccia also occurs. At Red Hill similar syenite, formerly described by W. S. Bayley, occurs on the summit, while, toward the periphery, nephaline appears as a constituent, and a true foyaite is developed. The massif is also cut by dikes, both camptonitic and syenitic. The region is to form the subject of a petrographic study by the two geologists in the near future.

Professor Daniel S. Martin described a visit which he paid during the summer to the noted mineral locality at Haddam, Maine. He described the manner in which the choicest specimens occur there, in veins of albitic pegamatite, with tourmaline, muscovite and quartz along the contact with the wall of gneiss. The mica plates along the contact are often two feet in diameter.

Dr. A. A. Julien in his paper 'The Geology of Central Cape Cod' reviewed the opinions of

Mitchell, Davis, Shaler and others on the geology of Cape Ann, with especial reference to the district from Chatham to Yarmouth. In the stratified deposits of sands and gravels which underlie the plains south of the morainal 'back-bone' of the Cape, the more frequent intercallation of clays was pointed out, and the occasional disturbance and flexure. Striated pebbles, although much water-worn, are quite largely interspersed. The discovery of true glacial silt at some depth in one locality indicates that the ice-sheet there rested, instead of floating. The kettle shaped hollows and pond-basins were shown by the speaker to be largely connected with the damming of surface streams, and some observations on the pre-glacial drainage valleys and topography were discussed. The identification of certain transported fragments of quartz-porphyry with outcrops of the same near Marblehead indicate a pre-glacial movement from N.N. W. to S.S. E. To the fifteen changes of level which have been recorded, a final small elevation probably should be added, judging from the low terrace along this part of the coast. Examples of the facited pebbles were exhibited and provoked considerable discussion among those present as to the origin of those pebbles.

Professor Richard E. Dodge recounted his pleasure in visiting the region of the Colorado Canyon, during the past summer, in company with a party, and finding the physiography, as graphically illustrated in the drawings in Powell's reports, to be a most faithful and non-diagrammatic portrayal of the features themselves. He then described the striking examples of gigantic geophysical results seen in the Great Kiabab anticline, the Grand Canyon itself, and the Kiabab plateau and its faults. He also described the appearance of the great basin of 'Lake Bonneville.'

Remarks on foreign localities visited by them during the summer, were made by Professor J. J. Stevenson and Dr. E. O. Hovey.

Theodore G. White,
Secretary of Section.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the Section was held on November 26. The first paper was a report of the Paris Congress of Psychology by Dr. R. S. Woodworth. This report was more detailed than the published accounts and also suggested certain questions in regard to the enlargement and control of American representation at similar congresses in the future.

The second paper, by Mr. Clark Wissler, on 'Correlation of Anthropometric Tests,' reported some results of a series of mental and physical tests upon students in Columbia University and Barnard College. The young women of Barnard College were found to be superior to Columbia freshmen in the tests for time of perception, naming of colors and resistance to pressure; they were equal to the freshmen in rate of fatigue, perception of weights, sensation areas, perception of size and logical memory; they were inferior in size of head, strength of hand, reaction time, association time and auditory memory. There is some probability that the young women are superior in perception of pitch and inferior in movement time. With the freshmen who repeated the test in their senior year an improvement was found in all except sensation areas and perception of size, though the difference in some cases is slight. It was also fouud that the seniors showed a decided tendency to hold the same relative rank as when freshmen, thus indicating a general advancement of the group during college life. In correlations it appeared that logical memory and length of head are related characteristics, but length of head also correlates with lung capacity and strength of hand. The work has not gone far enough to say which of these has the most weight. Attempts to correlate reaction time and the other tests of quickness gave no results.

The third paper, presented by Dr. E. L. Thorndike, reported the results of certain experiments on the 'Effects of Special Training on General Ability.' These experiments were performed jointly by Drs. Woodward and Thorndike. The results of a number of experiments show that when any mental function is trained in connection with certain data, the improvement is not of the function in general. If different data are used there will be less or even no improvement shown. The general theory that the mind equals a number of special abilities, independent to a degree hitherto unsuspected, was supported further by the great variability in our judgments of slightly differing magnitudes.

The fourth paper, by C. H. Judd was on the 'Movements of Writing.' These movements were analyzed by means of tracers attached to the hand, back of the fingers, and to the arm, back of the wrist. The written words give the sum of all the movements of arm, hand and fingers. The hand tracer gives only arm and hand movements, omitting finger movements. The arm tracer shows arm movements only. The general result of this analysis shows that the arm carries the hand forward and participates only to a very small degree in the formation of the letters and words. The gross movements, especially those which are upward and forward, in the formation of the letters, are performed by the hand. All the finer curves and more delicate lines of the letters are formed by the fingers. The muscular coordinations of the different individuals tested, while differing greatly in detail characteristics, all show this general type of movement. No results were presented from subjects who write naturally with a full arm movement.

Charles H. Judd,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 524th annual meeting of the Society was held on Saturday night, November 24th, at the Cosmos Club.

Under the title of 'An Attempted Solution of the Social Problem,' Mr. B. Pickmann Mann described the organization and history of the People's Real Estate Tontine, a philanthropic institution incorporated under the laws of New York State as a building and loan association, with the purpose of providing an annual income of increasing value with increase of age, especially for the relief of superannuated persons from poverty. The officers and trustees of this Association serve gratuitously and it has been endowed by gifts from many persons. This account of the last eight years' growth of the Association supplemented an account of the first eight years' growth, given before the Society by Mr. Mann under the same title in 1892.

The second paper was by Mr. F. O. Radelfinger, whose topic was 'Divergent Series.' After some preliminary remarks on the origin of divergent series, in which he pointed out a distinction between those which rise naturally from investigation in mathematics and those which are simply hypothecated, he passed to the consideration of some recent investigations by Borel.*

A first power series, assumed to be either divergent or convergent was written down, and a second more convergent series obtained from this by multiplying each term by a uniformly decreasing factor $a^n/n!$ A relation between these two series was to be deduced, which relation was expressed as a definite integral of a function of the second or derived series and certain simple transcendentals. Some applications of this relation were then given and its use in rendering the first series convergent in extending its original domain of convergence was pointed out. The relations discovered by Steitjie between certain divergent series and continued fractions were stated and their extension by Borel mentioned.

E. D. Preston,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 105th regular meeting was held November 28, 1900. The following papers were presented:

Mr. Arnold Hague, 'Account of the International Geological Congress at Paris, 1900.'

Mr. F. L. Ransome, 'The Fissure Systems of the Silverton Quadrangle, Colorado.'

The remarkably numerous and persistent fissures, in which occur most of the ore bodies of this portion of the San Juan Mountains, were described and classified. It was concluded that the forces which produced the fissuring were local in character and practically confined to the fissured area. They were probably genetically connected with the eruption and local accumulation of great thicknesses of volcanic rocks upon an ancient eroded basement.

F. L. Ransome,
David White,
Secretaries.

* *Annales de l'Ecole Normale*, 1899.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 328th meeting was held on Saturday evening, November 17th, and was devoted to a popular symposium on the subject of 'Malaria from a Biological Standpoint.'

C. W. Stiles described 'The Structure and Life History of the Parasites of Malaria,' illustrating his remarks with numerous diagrams. He noted the various theories regarding malaria and pointed out the steps by which our present knowledge of its cause had been reached, stating that Dr. A. F. A. King was the first to suggest that the mosquito was the direct agent in transmitting the disease. The manner in which the parasite passed from the water to the mosquito and thence to man was described in some detail, and the fact brought forward that various animals are subject to malaria produced by different parasites than those which cause the malaria of man.

L. O. Howard discussed 'The Malarial Mosquitoes, their Biology, what has been done and what may be done to Exterminate Them,' giving a full description of the biology of *Anopheles*, contrasting it with the life history of *Culex* and with the recently discovered and as yet unpublished life history of *Psorophora*, illustrating his remarks with lantern slides. He dwelt at some length on the subject of mosquito control, describing the different remedies and mentioning some cases in which, during the past summer, not only had the mosquito supply been greatly diminished, but in one malarial village malaria had practically been eradicated. He also described at some length the results of a very interesting experiment in community work at Winchester, Va., where the treatment of mosquito breeding places was made, during the past summer, a police measure.

F. A. LUCAS,
Secretary.

ZOOLOGICAL JOURNAL CLUB OF THE UNIVERSITY OF MICHIGAN.

AT the meeting of November 15th, Mr. Raymond Pearl gave an account of work carried on at Woods Holl on the reactions of the embryos and larvæ of *Limulus*. The normal movements and reactions of the adult had been studied, and a brief prefatory account of these was given. With this as a basis, the question was investigated whether there occurs a *development of reactions* comparable with the structural development. The results showed a distinct parallelism in many respects between the morphological development on the one hand and the psycho-physiological development on the other.

The Walking Movements.—Some time before the animal leaves the egg shell (or more properly, the 'vicarious chorion') purposeless kicking movements of the legs appear. After hatching, these movements continue, but gradually become coordinated by practice, until the perfected walking movement is produced from them.

The Swimming Reflex. — The swimming movements of the larva in the tribolite stage and for a week following the moult which terminates that stage are different from those of the adult. The adult swims by a combined, coordinated movement of the thoracic and abdominal appendages. In the young larvæ swimming takes place by the action of the gills, the legs being held perfectly quiet, strongly extended over the anterior edge of the thorax. The gills of the larva beat rhythmically from the first in a perfectly coordinated way. This movement begins within an hour after the animal leaves the 'vicarious chorion'; it is clearly a reaction due to the stimulation produced by direct contact of sea water with the gills.

Normal respiratory movements begin some time before hatching. The complicated chewing reflex of the adult is absent in young larvæ. The burrowing habit arises as a modification of the thigmotactic response of the larva.

To mechanical stimulation there is but one response, and this is the same, whatever part of the body is stimulated.

The phototactic, geotactic, hydrotactic and general thigmotactic reactions were discussed.

All the reactions were found to be of a peculiarly definite machine-like character, as if each were the result of the starting into activity of a distinct mechanism by a stimulus. The reactions appear as soon as their mechanisms are developed. So long as the mechanism is intact the response always takes place in the same way. The reactions can be analyzed into more or less simple, but distinct and specific, reflexes.

The fourth meeting was held November 22d. Dr. S. J. Holmes gave an account of some experiments on the development of fragments of the egg of *Pennaria*.

Mr. Raymond Pearl presented the results of a study of the motor reactions of the ctenophore *Mnemiopsis leidyi*.

Attention was directed especially to the question of how the organism moves with reference to the position of external objects acting as stimuli. To localized mechanical stimuli two distinct motor reactions were found to occur, depending on what part of the body was stimulated. (1) Stimulation in the region about the aboral pole caused an increase in the strength of the beat of the comb-rows, resulting in a movement of the animal straight ahead (toward the oral end): therefore *away* from the source of stimulation. (2) Stimulation of any other region of the body causes the following reaction: (*a*) the lobes close strongly, thus expelling the water rapidly and causing the animal to move backward (toward the aboral end). At the same time the comb-rows cease to beat. (*b*) The comb-rows on the side stimulated remaining partly or entirely quiet, the other comb-rows begin to beat strongly, carrying the animal forward and at the same time of course usually turning it *toward* the source of stimulus (never toward the opposite side). As the animal thus moves toward the source of stimulus the lobes are opened widely and the tentacles thrown back. This movement frequently brings the mouth of the animal against the stimulating agent, if the latter remains in place. This response is perhaps a *food reaction*. (This account is of a perfectly typical case, from which there are individual variations.)

Experiments were made on the relation of the central nervous system to the coordination exhibited in the contraction of the lobes. It was found that in animals from which the whole aboral end had been removed, including the whole of the central nervous system, there was still perfect coordination in the contraction of the lobes of the two sides. When a single lobe was removed from the body and split lengthwise so that the two parts remained connected only by a small bridge of tissue, the contraction of the two longitudinal halves was still found to be well coordinated.

H. S. Jennings,
Secretary.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

The Science Club of the University of Wisconsin held its first meeting of the academic year on the evening of November 27th. Dr. E. A. Birge, the new president of the Club and the acting president of the University, delivered an address upon 'Huxley.' Because of the very general interest of this address, the meeting was an open one and the large lecture hall of the University was crowded. Dr. Birge analyzed the qualities of mind and heart which characterized the great expositor of the doctrine of evolution. An interesting contrast was instituted between Huxley upon the one hand and first Matthew Arnold and then Gladstone upon the other.

While warmly sympathetic and eulogistic to a high degree, Dr. Birge's estimate of Huxley was in essential agreement with that of Gladstone, whose judgment was that however great Huxley's talents, he was not a genius.

Wm. H. Hobbs.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of November 19th, Mr. C. F. Baker exhibited a large amount of living and preserved material, including microscopic preparations, illustrative of American Isopods and Amphipods, accompanying the demonstration by a short *résumé* of the work thus far done on Crustaceæ, particularly on these two groups, and making some interestingly suggestive remarks on the peculiar affinities of a number of the species found in deep wells or hot springs.

Dr. Amand Ravold presented an abstract of the results reached in some recent bacteriological examinations of water from the Illinois, Mississippi and Missouri rivers, particularly concerning certain features of the occurrence and abundance of *Bacillus coli-communis*.

One person was elected to active membership.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

VON IHERING'S ARCHIPLATA–ARCHELEMIS THEORY.

In Science for December 7th, Dr. H. von Ihering gives a condensed statement of his views on the origin of the South American fauna. This is the more welcome, since the original publications of v. Ihering, although dating back to 1890, are not very well known, chiefly because these articles (of which v. Ihering gives a list) have been published in periodicals, in which hardly anybody would look for them. Part of them are of a mere popular character, while another part are too much out of the way, and they do not, by their titles, give any indication that we might look in them for a discussion of zoogeographical topics of general interest.

As regards the chief idea of v. Ihering, that South America consists, genetically, of two different parts, *Archiplata* and *Archamazonas*, which have become united subsequently, I am of the opinion that this theory is well worth discussion. Indeed, I have accepted this theory in my studies of the distribution of the freshwater Decapods, and have been able to collect further material in support of it. And further, in the report on the Tertiary Invertebrates of Patagonia, collected by the Princeton Expedition, which is in course of preparation, I shall again refer to this theory as a very acceptable one for the explanation of certain features in the distribution of marine animals. Therefore, I was much surprised to see that v. Ihering refers to my studies on the freshwater crabs and crayfishes as at variance with his theory, for only in this sense I can interpret his reference to my 'biologic' barrier.

My theory of a 'biocœnotic barrier' formed by the *Potamonidæ* (tropical fresh-water crabs) for the *Potamobiidæ* and *Parastacidae* (crayfishes, restricted to the extratropical parts of either hemisphere) was formulated to explain only the *Bipolarity* of the latter groups, without any reference to the special conditions in South America, but chiefly in respect to those prevailing in the old world.* I shall discuss this question again,† and shall pay particular attention to the South American conditions with reference to v. Ihering's theory: I think that the South American *Parastacidæ* are members of the old Archiplatan fauna, and are connected genetically with the New Zealandian and Australian *Parastacidæ*, and have reached these parts apparently by way of a land connection across the Antarctic regions, while the South American *Potamocarcininæ* (subfamily of *Potamonidæ*) are characteristic of the old Archamazonian fauna, and point possibly to a former connection of the latter with Africa (v. Ihering's *Archhelenis*). In this connection I must add that v. Ihering's argument, given in the article referred to, as to the coexistence of *Potamocarcininæ* and *Parastacidæ* in southern Brazil is probably a mistake: there are to my knowledge no *Potamocarcininæ* in southern Brazil, but the fresh-water crabs of small size, to which he probably alludes, are *Trichodactylinæ*, the genetic relations of which are doubtful. They have nothing at all to do with my 'biocœnotic barrier,' and certainly do not 'annul' it.

In favor of the theory of a former disconnection of the northern and southern parts of South America I may call attention to other considerations. A commuuication of the Atlantic and Pacific Oceans in Tertiary times is generally accepted, and this connection is chiefly placed at Panama. Now (according to Hill), ‡ the Isthmus of Panama was land since Mesozoic times (with only an unimportant interruption at the end of the Eocene); but Hill himself admits that there must have been a connection of oceans somewhere in the Tertiary. The theory of v. Ihering gives us a clue to this. If we move the interoceanic connection from Panama southward, and construct it where there must have been the sea separating Archamazonas and Archiplata, that is to say, across

* See 'Bipolaritaet' in: Zool. Jahrb. Abt. f. Syst. v. 9. 1896, p. 593.

† 'Decapoden' in Bronn's 'Klassen und Ordnnngen,' vol. 5 Abteil. 2, p. 1289. This part has not yet been issued, and I am quoting from proof sheets.

‡ *Bull. Mus. Comp. Zool.*, v. 28, No. 5, 1898.

the South American continent about where there is now the Amazonas valley, we should still have a communication between both oceans within the tropics. Just this kind of connection is demanded by the facts that have led to the assumption of an interruption of the isthmus of Panama.

The former connection of v. Ihering's Archiplata with a supposed Antarctic continent is no new theory, but goes back, in this form, as far as Rütimeyer (1867), and I have no doubt that we should accept it.* But we hardly can accept it in the shape of Forbes' 'Antarctica' (1893). This huge continental mass is simply impossible, and Professor Osborn (Science, April 13, 1900) has very properly tried to restrict it to a reasonable size; but I think we should still more contract its boundaries. In this respect I should follow Hedley's† views, who practically, but without giving a map, accepts the limits of the present Antarctic continent (as defined by Enderby, Wilke's, Victoria and Graham Land), with only such extensions as are absolutely necessary to connect it with the present southern continents.

A. E. Ortmann.

Princeton University,
Dec. 7, 1900.

* An historical account of the different theories advanced for the explanation of the relations of the southern faunas, and a classification of them, will shortly be published in the *American Naturalist.*

† Proc. Roy. Soc. N. S. Wales, 1895, August 7th.

THE LONGEST AËRIAL VOYAGE.

To the Editor of Science: The official report just received of the long-distance balloon race from Paris on October 9th, changes somewhat the figures on page 799 of Science, which were those furnished to the press. It appears now that Count de La Vaulx and a companion traveled 1,200 miles in 35 hours and 45 minutes in the basket of a balloon containing only 57,000 cubic feet of illuminating gas. They reached a maximum height of three and a half miles, crossed Germany and landed in Russia, as did another of the contestants. This is probably the longest continuous voyage in the air ever made, although it was nearly equaled forty years ago by our countryman, John Wise, who, with two companions, went by balloon in 19 hours from St. Louis to Jefferson County, New York, a distance of 1,150 miles.

It is evident that, under the management of an aëronaut, a balloon can be kept longer in the air than an unmanned balloon, but, nevertheless, a balloon of 8,700 cubic feet capacity, carrying only self-recording instruments, which was liberated from Berlin in 1894, after attaining a height of ten miles was carried 700 miles to the borders of Bosnia, at a speed of 62 miles an hour. Still more remarkable, in its way, was the flight of a pair of kites last summer from the Royal Aëronautical Observatory near Berlin. Five kites, which had lifted self-recording meteorological instruments to a height of two and a half miles, broke the wire that confined them to the ground and the two upper kites dragged it across the country for nearly a hundred miles before they were finally checked, the trailing wire, two miles in length, furnishing sufficient resistance to keep the kites flying throughout the night.

A. Lawrence Rotch.

Blue Hill Meteorological Observatory,
November 30, 1900.

'THE CRIMINAL, HIS PERSONNEL AND ENVIRONMENT.'

To The Editor of Science: Disclaiming in any sense to answer the attack upon my recently published book, 'The Criminal, his Personnel and Environment,' emanating from the pen of Mr. Havelock Ellis and published in your valued journal of the 19th inst., I nevertheless deem it but justice to myself to ask of my critic a verification of the assertion therein made, that: "When he (the author) mentions authorities he is unable in *a large proportion of cases* even to *spell their names*" (the italics and parentheses are my own). Now, as I happen to cite a very large number of names, and while fully conscious of my liability to err, the charge is an exceedingly broad, if not hazardous one, which, if failing to substantiate, will lay my critic open to a grave counter-charge. I respectfully challenge Mr. Ellis to make good his proofs, which, if true, may readily be done. In the event of his inability so to do, I then ask for a *modicum* of such proofs, and failing in this, and, in view of the fact that I am just completing the proof sheets for the second edition (since March) of my book, I should deem it in the light of a personal kindness as well if he would favor me with the evidence of one or more such errors, naming paragraph and page.

As to any further animadversion upon my work, I am willing to leave its merits to the just judgment of the reading public and my colaborers in the field of practical penology rather than to the dictum of the study and the essay of theorists at long range.

August Drähms.

San Quentin, Cal.

At Mr. Drähms's request I have rapidly turned over the pages of his book and noted down a few of the liberties taken with the names of authors quoted or referred to :—Taylor (for Tylor), *passim;* Galt (for Gall) p. 22; Von Homel (for Van Hamel) p. 23; Ferrer, (for Ferrero) *passim;* Tamborini (for Tamburini) p. 46, Tyndale (for Tyndall) p. 51; Masso (for Mosso) p. 69; Gradinger (for Gradenigo) p. 78; Berdier (for Bordier) p. 87; Herman Schaafhausen (for Hermann Schaaffhausen) p. 95; Lelart (for Lélert) p. 105; Weissmann (for Weismann) *passim;* Thompson (for Thomson) p. 138; Delboef (for Delbœuf) p. 319; Frey (for Fry) p. 334. It would be easy, but is probably unnecessary, to enlarge this list very considerably. Some of the names are so changed that it is hazardous to identify them, more especially since Mr. Drähms seldom supplies definite references. When he does they are sometimes remarkable. Thus I find (p. 95) a reference to Ecker given as 'Crania Germanice,' *Merid. Occid.*, Freib. i. p.'; it may interest Mr. Drähms to know that this being interpreted, means '*Crania Germaniæ meridionalis occidentalis*, Freiburg, i/Br.'

Mr. Drähms will, I hope, believe me when I say that the other statements in my review may be as fully proved as that to which he takes special exception. He is mistaken in thinking that I wish to 'attack' his book; I have no desire whatever to judge him hastily. But he has chosen to challenge examination of his book as a 'scientific study,' and he must not feel aggrieved when it is submitted to very elementary tests of scientific precision.

Havelock Ellis.

Lelant, Cornwall.

NOTES ON INORGANIC CHEMISTRY.

The use of acetylene in the blast lamp has been tested by many experimenters, and it has been found possible to obtain easily a heat at which gold can be readily fused. In the October *Moniteur Scientifique*, G. L. Bourgerel has described experiments in replacing air in the acetylene blast lamp with oxygen. When pure oxygen is used the flame becomes highly luminous and deposits carbon in very compact form, much resembling gas carbon. When, however, a mixture of air and oxygen is used with acetylene, the gas is completely burned, and it was found possible to obtain a temperature high enough to fuse platinum. There would seem to be no particular practical advantage in the use of this flame over the commonly used oxygen-coal-gas blast lamp.

Hydrogen tellurid was discovered by Davy, in 1810, by the action of hydrochloric acid on sodium tellurid, but the gas has never been obtained pure, and beyond its odor and its instability comparatively little has been known of its properties. The problem has been taken up by Dr. Edmund Ernyei, of Budapest, and his results are described in the last number of the *Zeitschrift für anorganische Chemie.* After testing several methods, the best was found to be the electrolysis of 50 per cent. sulfuric acid by a 220 volt current with a tellurium kathode. The apparatus was kept at a temperature of —15° to —20° and the evolved gas dried immediately over calcium chlorid and phosphorus pentoxid. It was then condensed by the use of liquid carbon dioxid, and formed orange-yellow crystals which melt at —54° to a greenish yellow liquid. This hydrogen tellurid proved to be practically pure. Its boiling point is slightly above 0°, but it decomposes quite rapidly below this temperature into tellurium and hydrogen. It is quite soluble in water, but its solution decomposes on contact with the air. In caustic alkalies it dissolves, forming alkaline tellurids, which decompose readily, and on standing these become dark red from the formation of polytellurids. Its density was obtained by the Dumas method, and by rapid working the decomposition was so slight as to have no appreciable effect upon the result. The value found was 65.1 which corresponds to the formula H_2Te. From this the molecular weight would be 130.2. These properties of hydrogen tellurid correspond to the position of tellurium in the sulfur-selenium group, while the high molecular weight agrees well in confirming the best atomic weight determination of tellurium, which places it above and not below that of iodin.

In connection with the proposed formation of a new 'Society of Chemical Industry of Victoria,' a correspondent of the *Chemical News* takes exception to the term 'English Society' by the Honorable Secretary of the Victoria Society as applied to the Society of Chemical Industry, in the following language: "Our Society is not, I think, an 'English' Society merely; it is not merely a British Society; it is an Anglo-American Society. Its President of last session was an American, and I believe we are proud of both these facts. * * * It seems strange that Mr. Gepps in his circular should omit our most prosperous and rising section, next to that of London, viz., the New York Section of the Society of Chemical Industry. He probably would not have made the omission, however, had he been present at our annual general meeting this summer, and witnessed the enthusiastic reception accorded to our American President, and have heard his address, and especially his speech at the annual dinner of the Society. If there is one thing we of the Society of Chemical Industry are more proud of than another, it is of the fact that in the Society and its journal the hands of British and American technical chemists are united—spite of the broad Atlantic—in a brotherly grip." To all of which we say Amen.

J. L. H.

JESSE WILLIAM LAZEAR.

At a meeting of the Johns Hopkins Hospital Medical Society on October 16th, Dr. W. S. Thayer, referring to the recent death from yellow fever of Dr. Jesse William Lazear, addressed the Society as follows: Before we proceed with the program this evening, I should like to say a few words about our dear friend Lazear, whose sad death at Quemados, Cuba, on September 25th, is so fresh in our minds. Lazear was born just outside of Baltimore thirty-four years ago. He graduated at the Academic Department of the Johns Hopkins University in 1889, and three years later obtained the degree of M.D. from Columbia University, New York. After this he was an interne in the Bellevue Hospital for two years. After spending the greater part of the year in studying abroad, particularly in Paris, he returned in 1895 and became one of the medical staff of the Johns Hopkins Hospital. In the summer of 1896, Dr. Lazear was married and began the practice of medicine in Baltimore. At the same time, however, he was an assistant in clinical microscopy in the University, and in the laryngological department in the Hospital dispensary. Last winter he obtained an appointment as assistant surgeon in the army with special laboratory duties, and was stationed in Havana. There he soon became interested in the study of yellow fever, and for several months he had been one of the commission appointed by the Surgeon General, for the study of this disease. He had been constantly exposed to infection, and finally, in the course of his duty, contracted his fatal illness.

Dr. Lazear was a man of few words but keen perception. He was an extremely careful and thorough worker. He kept his own counsel, asked few questions and little help of his associates, but he was a man who, when he started an undertaking, had the ability and enthusiasm to keep quietly at work until he accomplished his end. It was through his excellent work that we were able several years ago to make our first positive *intra vitam* diagnosis of septicæmia due to the diplococcus of Neisser. His valuable studies upon the internal structure of the malarial parasite, which I had the pleasure of bringing before this Society last winter, are remembered by all.

Personally, he was an exceptionally simple, high-minded and lovable man. He could not have failed to find in a short time a public position in which his unusual merits would have become more generally known.

I should like to suggest to the Society the adoption of the following resolutions :

"*Whereas,* On the 26th day of September, our beloved colleague and friend, Jesse William Lazear, lost his life in the discharge of his duty as a member of the United States Yellow Fever Commission ;

"*And whereas,* His exceptional ability in his profession, his simplicity and modesty as a man, had greatly endeared him to all whose good fortune it was to know him ;

"*Be it resolved,* That we, his former colleagues and associates, do hereby express our profound sorrow at the loss to the community of one whose future was unusually rich in promise, to ourselves, of a dear friend and fellow student ;

"*And be it further resolved,* That we express to his wife and family our warmest and most heartfelt sympathy.

The resolutions were unanimously adopted.

SCIENTIFIC NOTES AND NEWS.

THE mid-winter meeting of the Council of the American Association for the Advancement of Science will be held at 1 o'clock, P. M., Friday, December 28th, in Room 12, McCoy Hall, Johns Hopkins University, Baltimore.

AT the anniversary meeting of the Munich Academy of Sciences on November 14th, Professor W. C. Röntgen was elected an ordinary member ; Professor S. Günther, of Munich, was elected an associate member ; Professors W. Wundt, Leipzig, O. Bütschli, Heidelberg, W. His, Leipzig, and H. de Vries, Amsterdam, were elected corresponding members, and Professor Poincaré, Paris, a foreign member.

DR. KARL KLEIN, professor of mineralogy at Berlin, has been elected a corresponding member of the Paris Academy of Sciences.

THE Cross of Commander of the Legion of Honor has been conferred by the president of the French Republic on Sir William McCormac, president of the Royal College of Surgeons of England.

OXFORD University will confer the degree of D.Sc., *honoris causa*, upon Dr. Oliver J. Lodge, principal of the University of Birmingham.

THE Berlin Academy of Sciences has made the following appropriations: To Herr Engler, toward the publication of 'Das Pflanzenreich,' 2,000 Marks; to Professor Otto Lehmann, of Karlsruhe, for the continuation of his investigations on fluid crystals, 1,200 Marks; to Professors Friedrich Paschen and Karl Runge, Hanover, for an electro magnet, 1,400 Marks, and to Dr. Karl Peter, of Breslau, for studies on the development of lizards, 500 Marks.

DR. H. M. SMITH, of the U. S. Commission of Fish and Fisheries, has recently returned from a three month's trip to Europe, during which he visited a number of biological stations, including those at Plymouth and Naples. At the International Congress of Fisheries and Agriculture, held at Paris in September, Dr. Smith was the official delegate of this government.

A BUST of Charles H. Haswell, the first engineer-in-chief of the U. S. Navy, is in process of completion, by Dunbar, for the Union Club of New York. Mr. Haswell is now in his ninety-second year and is still active, going to business every day and looking no older, his friends say, than he did thirty years ago. He was the first officer in the navy to introduce scientific methods in engineering and constructed the engineer corps of that service. After he had organized the corps, he designed much of the then novel machinery of steam propulsion. A few of his steam war vessels still survive, in retirement. He published the first table-book for engineers, and that famous pioneer work is still published by the Harpers, and has passed through about fifty editions in something over a half century. His semi-biographical 'History of New York' is probably better known to the majority of his fellow townsmen.

CAMBRIDGE University will confer its M.A., *honoris causa*, on Mr. G. H. F. Nuttall, M.D., (California), Ph.D. (Göttingen), university lecturer in bacteriology and preventive medicine, and on Mr. T. Strangeways Pigg, university demonstrator of pathology.

DR. H. R. MILL has resigned the librarianship of the Royal Geographical Society, and will be succeeded by Mr. E. Heawood.

WE learn from *Nature* that at the annual meeting of the Royal Geological Society of Cornwall, Dr. Le Neve Foster was presented with the William Bolitho gold medal in recognition of the distinction which he has attained as a mineralogist, and also of the great services rendered by him to the Society as curator during the period when he held the appointment of inspector of mines for Cornwall and Devon.

The committee on a memorial of the late Dr. Joseph Coats, who was the first occupant of the chair of pathology in the University of Glas gow, has established a scholarship to be known as the 'Joseph Coats Memorial Scholarship in Pathology,' for the encouragement of original research. The value of the scholarship, which will be awarded once in two years, is the income of the endowment of £1,200. A brass memorial tablet will be placed in the Pathological Institute at the Western Infirmary, Glasgow.

Professor John Gardiner, LL.D., who occupied the chair of biology in the University of Colorado, at Boulder, Colorado, from 1889 to 1898, died as a victim of consumption on November 26. Professor Gardiner, who was thirty-eight years of age, was a graduate of the University of London, B.Sc., 1884, and was awarded the table of the British Association at the Naples Biological Station in 1887. He was an enthusiastic student of biology, a man of rare culture in other lines and a stimulating teacher and lecturer.

We regret to record the death of Dr. Adolph Pichler, at Innsbrück, at the age of 81 years. Dr. Pichler was for many years professor of geology at Innsbrück and was at the same time one of the more eminent German poets and men of letters. He was the author of tragedies, epics and lyric poems which are much esteemed by the critics. Even if there were only the names of Pichler and Camisso, the eminent German poet and botanist, it would be proved that a man of science is far more likely to be a poet than is the average man.

The death is announced of Professor M. F. Kovalskij, professor of pure mathematics at Charkow; of Emanuel Formánek, professor of pharmacology at the Bohemian University of Prague, and of M. A. Pellerin, director of the botanical garden at Nantes.

Professor George E. Hale, director of the Yerkes Observatory, asks us to announce that appointments will be made to two new positions on the staff of the Observatory, before July 1, 1901. The holders of these positions will be expected to devote the principal part of their time, a specified number of hours per day, to the measurement and reduction of photographs of spectra or to other work of computing. Opportunity will also be given to become familiar with the investigations in progress at the Observatory, and perhaps to take part in them during hours not devoted to measures and reductions. The applicant should be familiar with the practical use of the method of least squares, and must possess good eyesight. Preference will be given to men trained in the measurement and reduction of photographs. It is probable that one of the positions will be given to a man experienced in astronomical methods, the other to one whose work has been mainly in a physical laboratory. In neither case can assurance be offered that the appointment will be for more than one year, as funds are not now available for a longer period. The salary will be $800. As it is desired to fill one of the positions about January 1, 1901, applications may be sent at once to the director of the Yerkes Observatory, Williams Bay, Wisconsin.

The Postmaster-General issued, December 5th, the following order, No. 1,851: "Ordered: That Theodore C. Search, President of the National Association of Manufacturers, Philadelphia, Pa.; R. H. Thurston, director of Sibley College, Ithaca, N. Y.; Wm. F. King, president Merchants' Association, New York; Alfred Brooks Fry, chief engineer and superintendent of repairs, U. S. Public Buildings, New York, N. Y.; Wm. T. Manning, consulting engineer, Baltimore, Md.; and Frederick A. Halsey, mechanical engineer and editor *American Machinist*, New York, N. Y., be and they hereby are appointed a committee of experts to give consideration to all matters pertaining to the use of pneumatic tubes for the transmission of mail and to advise the Postmaster-General thereon pursuant to the Act of Congress approved June 2, 1900." The committee met December 10th and will report within ten days, advising the Postmaster-General regarding the lease or the purchase, the extension, the restriction, or the disuse, of that system of transmission of mail matter. It is now in use in New York, Philadelphia and Boston, and is asked for in other large cities.

A DESPATCH from Berkeley states that Mr. D. O. Mills, of New York, has promised the University of California about $24,000, to defray the expenses of a two years' astronomical expedition from the Lick Observatory to South America or Australia, the object of which is to study the movement of stars in the line of sight.

MR. GEORGE WHARTON JAMES will lecture before the Philadelphia Academy of Natural Sciences on the 14th instant on 'The Wallapais: the Bedouins of the Painted Desert of Arizona.' The illustrations will be from photographs taken last summer. Dr. John W. Harshberger will make a communication at the regular meeting of the 18th inst. on the 'Ecology of the New Jersey Strand Flora.'

DR. A. DONALDSON SMITH, the African explorer, is to lecture before the Philadelphia Geographical Society on January 2d.

WE regret to hear that the fine collection of Mr. Jas. L. Bowes, of Liverpool, the basis of Audsley and Bowes' 'Ceramic Arts of Japan' is likely to be sold and dispersed.

A COLLECTION of 1,200 Indian baskets has been presented to the Ferry Museum of Tacoma, Washington, by Captain Tozies.

THE geological survey of Louisiana will be continued this winter as usual under the immediate direction of Professor Harris, of Cornell University. He leaves for New Orleans, December 20th, taking with him Mr. J. Pacheco, a student in the University from Brazil, as assistant in place of Mr. A. Veatch, who has resigned to continue his work at the University.

A TELEGRAM has been received at the Harvard College Observatory, through Mr. Percival Lowell, stating that Mr. A. E. Douglass, while observing the planet Mars on December 7th, saw a projection on the north edge of Icarium Mare, which lasted seventy minutes.

THE Paris correspondent of the London *Times* reports that M. Emile Berr has just announced a scheme, at the head of which are M. Baudin, Minister of Public Works; M. Millerand, Minister of Commerce; M. Leygues, Minister of Education; and M. Alfred Picard, the General Commissioner. The scheme consists in the preservation in that portion of the banks of the Seine on the Quai d'Orsay of 12 out of the 16 Palaces of the Nations in the recent exhibition. The palaces to be taken down would be those of Italy, Turkey and Servia at either end, and the palace of Spain in the middle, the space left vacant to be filled up by the pretty pavilion of Finland, now in the second row. Each palace thus preserved would become a special museum, the fine characteristic country house of England being converted into a museum of hygiene and bacteriology—a museum of honor to the memory of Pasteur and Lord Lister. These 12 museums, which will last ten years at least, would be kept up by the organizers, and the project honors both those who have invented the idea and the nations which designed these palaces. The cost of the undertaking would be about 1,000,000 f.

The Philippine Commission is about to establish an experimental farm about 200 miles from Manila which will be under the direction of Mr. Phelps Whitmarsh.

IN his annual report to the President, the Secretary of the Interior says, concerning the value of Forest preservation by the government: "The forest policy, as inaugurated by my immediate predecessor in office, has been continued during the year, and the results obtained in the conservation of the national forests and the protection of timber on reserved as well as unreserved lands have demonstrated the wisdom of its adoption, and the necessity, in the interest of the public, for its continuance and increased appropriations by Congress for the carrying on of the work. I concur in the commissioner's recommendation that not less than the appropriation of $300,000 for the forest service, in connection with the creation and administration of forest reserves, be continued for next year, with a possible increase in case additional lands are set aside as forest reservations."

THE Association for Promoting Scientific Research by Women offers a prize of one thousand dollars for the best thesis presented by a woman on a scientific subject, embodying the results of her independent laboratory research in the biological, chemical or physical sciences. The theses must be submitted before the end of the year 1902. Further information may be obtained from the secretary *pro tem.*, Miss Florence M. Cushing, 8 Walnut St., Boston, Mass.

The Röntgen Society of the United States meets at the Grand Central Palace, N. Y., on December 13th and 14th. A full program is announced, but it does not contain the names that should be represented in a society of this character.

An International Engineering Congress will be held at Glasgow in connection with the International Exhibition of 1901. The arrangements are being made by the Council of the Scottish Institution of Engineers and Shipbuilders, and Lord Kelvin will preside.

The New York State paleontologist Dr. John M. Clarke spent several weeks of the last season in Nova Scotia, New Brunswick and Quebec making collections from rocks which have for the most part been regarded by the Canadian geologists as of the same geologic age as the Helderbergian of New York. Careful studies and extensive collections were made at Arisaig, N. S., Dalhousie, N. B., and on the Gaspe peninsula, thus putting the museum in possession of a series of fossils of much importance for correlation and study which are not duplicated in this country outside of the National Museum at Washington. The accessions to the paleontologic collections during the past season, including all that has been acquired in the work above specified, have been not less than 10,000 specimens. The museum has also recently come into possession by purchase of the important collection of Cambrian fossils made by the late Silas W. Ford, of Troy, a very keen observer and careful student of the Cambrian rocks. This collection, though small, contains all the types of species described and illustrated by Mr. Ford, and much of the material is derived from localities at which it seems now impracticable to obtain others.

The following are the arrangements for the lectures at the Royal College of Physicians of London for 1901: 'The Milroy Lectures on Public Health' will be given by Dr. J. F. Sykes, Medical Officer of Health for St. Pancras, on February 28th, March 5th and 7th; the 'Goulstonian Lectures,' by Dr. Henry Head, F.R.S., on March 12th, 14th, and 19th; the 'Lumleian Lectures' by Dr. Frank Payne, on March 21st, 26th, and 28th, and the 'Croonian Lectures' by Professor Halliburton, F.R.S., in June.

In the Registrar-General's quarterly report the population of the United Kingdom is estimated at nearly 41,000,000. The births for the last quarter exceed the deaths by 123,952. 105,402 persons were during the same time officially recorded as having emigrated.

UNIVERSITY AND EDUCATIONAL NEWS.

By the will of the late Rudolph S. Walton, of Philadelphia, the bulk of his estate of $240,000 will go to Bethany College upon the death of his wife.

We learn from the *British Medical Journal* that the Faculty of Medicine of Paris has decided that provision should be made for the teaching of tropical medicine. A chair of parasitology and another of bacteriology will be established. An appeal is to be made to the public for funds to carry the scheme into effect.

At a recent meeting of the Board of Trustees of Clark University, Worcester, Mass., the following promotions were made: Dr. Edmund C. Sanford, to be professor of experimental and comparative psychology; Dr. Arthur G. Webster, to be professor of physics; Dr. William H. Burnham, to be assistant professor of pedagogy; Dr. Alexander F. Chamberlain, to be acting assistant professor of anthropology. The Trustees also voted, at the same meeting, to open all the privileges of the University to men and women upon equal terms.

Dr. Gustav Bauer, professor of mathematics in the University at Munich, has retired at the age of eighty years.

Dr. C. E. Guye has been appointed professor of physics in the University of Geneva. Professor Weiss has been made full professor of mathematics and analytical mechanics at the German Polytechnic Institute at Prague.

Dr. Brillouin has been nominated to succeed the late Professor Bertrand as professor of general and mathematical physics at the Collège de France.

SCIENCE

FRIDAY, DECEMBER 21, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE MAMMALIAN FAUNA OF THE SANTA CRUZ BEDS OF PATAGONIA.**

THE magnificent collections of vertebrate fossils brought back from Patagonia by Messrs. Hatcher and Peterson are still very largely in the rough state. The work of cleaning and preparing the specimens is proceeding steadily and satisfactorily, but is necessarily slow, and the preparation of a single skeleton may require the labor of many weeks. Enough has been already accomplished, however, to exhibit the character of this very remarkable fauna in its main outlines and to permit a general statement of its most salient features. Long and patient study will still be necessary before the full significance of this peculiar assemblage of mammals can be made apparent.

The geological age of the Santa Cruz beds has long been a matter of dispute, because the lack of fossils common to that formation and the standard horizons of the northern hemisphere has prevented any direct comparison. Ameghino, to whose indomitable energy so much of our knowledge of Patagonian fossils is due, has always maintained the lower Eocene age of the Santa Cruz beds. On the other hand, European and American paleontologists have been convinced, from the grade of evolution attained by the Santa Cruz mammals,

* Abstract of a paper read before the Princeton Biological Club, November 16, 1900.

that the horizon could not be so ancient and that it much more probably belonged to the Oligocene or Miocene. Fortunately, the solution of this problem does not depend upon theoretical views of mammalian morphology, but may be decided by more direct and satisfactory evidence. The Santa Cruz beds overlie and are, to some extent, interstratified with the marine Patagonian formation, which is very richly fossiliferous and from which Mr. Hatcher gathered very extensive collections of marine invertebrates. These have been carefully studied by Dr. Ortmann, who concludes from his examination that the Patagonian beds are *Lower Miocene*, and the Santa Cruz beds, as a whole, are, therefore, still younger, that is, Middle, or possibly even Upper Miocene.

The first impression that an examiuation of a representative series of Santa Cruz fossils makes upon the northern observer is that of strangeness, of unlikeness to everything with which his previous studies have made him familiar, and this impression is only deepened as these mammals are compared with those of North America and Europe. Disregarding some very doubtful and incompletely known groups, the Santa Cruz fauna is composed of the following elements.

1. Marsupialia.
2. Unguiculata,
   (*a*) Insectivora,
   (*b*) Edentata,
   (*c*) Rodentia.
3. Ungulata,
   (*a*) Typotheria,
   (*b*) Toxodontia,
   (*c*) Astrapotheria,
   (*d*) Litopterna.
4. Primates.

One of the most striking features of this fauna may be described negatively, by what it lacks; it has no Carnivora or Creodonta, no Chieroptera (though little importance can be attached to this fact, which may well be accidental); no Artiodactyla, Perissodactyla, Proboscidea or Hyracoidea. Of the nine orders only four are found in the Miocene of the northern hemisphere (for the Old World Edentates, so called, are of no significance in this connection), and even these common orders are represented by totally different suborders and families. That Patagonia had long been cut off from any land communication with North America seems abundantly clear.

The Santa Cruz Marsupials are of two types: (1) Carnivorous animals, which took the place of the carnivores and creodonts of the North; these find their nearest analogues in the *Dasyuiidæ* of Australia, but there are such important differences of structure as to indicate a long geographical separation from that family. (2) Herbivorous animals, of small size, quite remote from any of the Australian forms and typified by the existing South American *Cœnolestes* of Thomas.

The Insectivora are represented, so far as is yet known, by only a single genus, *Necrolestes*, which, as Ameghino has suggested, is very like the 'Cape Golden Moles' of Africa, a most interesting fact, the full significance of which is not yet apparent.

The Edentata are found in surprising variety and numbers, making up one of the most conspicuous and characteristic elements of the fauna. Forerunners of the huge Ground-sloths (Gravigrada) of the Pleistocene, are extremely abundant and are represented in the collection by a number of such well preserved skeletons that a comparison with their great descendants cannot fail to yield results of much interest. One difference is obvious at the first glance, namely, the very much smaller size of the older genera. Much the same statement is true of the Glyptodonts, which are very numerously represented by species much smaller and more primitive than their Pleistocene successors. The Armadillos are likewise extremely varied and abundant, representing not only the various modern subdivisions of the family, but also some extraordinarily interesting and curious extinct lines. Ameghino has already called attention to some of the peculiarities of these Santa Cruz Armadillos, such as the movable arrangement of the bony scutes of the carapace, which do not form a fixed shoulder-shield, and the imbricatin , overlapping disposal of the scutes in several of the species. As yet no member of the Anteaters or true Sloths has been detected in the collection, and it is still too early to say whether this absence is due to the accidents of fossilization and of collecting, to geographical and climatic factors, or to the fact that these families had not yet become distinctly separated from the others.

Even more surprisingly abundant and varied are the Rodentia, of which a remarkable number of genera and species may be distinguished. These are, without one certainly known exception, members of the Hystricomorpha and are all closely allied to types which continue to flourish in South America at the present time. Indeed, several of the fossils cannot be generically separated from living forms. In all this great assemblage of rodents are to be found no beavers, marmots or squirrels, no rats or mice, no hares, rabbits or pikas, but only a bewildering variety of cavies, pacas, chinchillas, agoutis and the like. In no mammalian order are the isolation of the Santa Cruz fauna and its separateness from that of the northern hemisphere more clearly displayed than in the Rodentia.

Still more peculiar are the hoofed-animals. The four orders into which this great series is divided in the table do not represent the results of mature study, but merely of a preliminary survey of the material, and the number of ordinal groups is subject to increase or diminution, as may be the outcome of more careful examination. Of the four orders not one is known in the Miocene of the northern hemisphere, nor, on the other hand, does the Santa Cruz contain representatives of any ungulate order common to it and the northern continents. All the four orders, except the Astrapotheria, continue into the Pleistocene, when most of them had become beasts of great stature or bulk; but then they all disappeared completely and have left no descendants in the modern world.

The Typotheria are individually much the most numerous of the Santa Cruz ungulates and they are, within certain narrow limits, extraordinarily varied. They are all small animals, some of them very small, and except for their long tails, of an aspect which strongly suggests relationship with the Hyracoidea. Whether this resemblance is anything more than an analogy, remains to be determined by a series of careful comparisons. This phylum terminates in the rodent-like *Typotherium* of the Pleistocene, an animal which, though only of moderate size, is yet very much larger than any of its Santa Cruz predecessors. The order has not been found outside of South America.

The next most abundant of the Santa Cruz ungulates is the order Toxodontia, which is very much less varied than the preceding group, though its members are much larger in size. These relatively massive, short-legged and short-footed animals are remarkable for the great size of their heads and for their curved, persistently growing teeth. This line also terminates in the Pleistocene in the great *Toxodon*, which ranged as far north as Nicaragua. The supposed representatives of the order which have been reported from Europe are simply mistakes of identification.

Most remarkable and interesting of all the Santa Cruz ungulates are the Litopterna, which in many respects closely parallel the Perissodactyla. Of these there are two series, one of long-legged, long-necked, camel-like animals, which led up to the

Pleistocene *Macrauchenia;* the other an astonishing imitation of the horses, an imitation so detailed and so close that it has misled Ameghino into believing that this is the actual phylum of equine descent. The resemblance is striking in all parts of the structure; in the teeth, the skull, the backbone, the limbs and especially the feet. The less advanced forms have tridactyl feet, but with the lateral digits already greatly reduced, while the more differentiated species surpass the true horses in strict monodactylism, the splint-bones being almost suppressed and represented only by minute nodules of bone. Yet these wonderfully horse-like creatures prove, on examination, to be not even perissodactyls! A more remarkable and instructive case of convergent evolution it would be difficult to imagine.

The Astrapotheria were the largest of Santa Cruz mammals. In them the great, vaulted skull had such shortened nasal bones as to suggest the presence of a proboscis, and slender, edentulous premaxillaries. The canine teeth in both jaws are enlarged to form powerful and formidable tusks, the premolars are reduced in size and number, while the molars are enlarged. The grinding teeth display a remarkable likeness in size and pattern to those of the northern rhinoceros, *Metamynodon*, from the White River beds—another example of convergent development. The Astrapotheria would appear to have become extinct before the Pleistocene, and it must be the object of subsequent studies to determine whether the group is really entitled to ordinal rank, or whether it should be referred to the Litopterna.

I am not prepared to express an opinion as to the taxonomic position of *Homalodontotherium*, one of the most curious of the many curious Santa Cruz hoofed-animals.

The Primates are not very well known as yet, for the fossils are seldom so complete as those which so often rejoice the heart of the student who works with the other groups. So far as they are understood, the Santa Cruz monkeys would appear to be as characteristically South American, and as different from those of the northern hemisphere, as we have seen to be the case among the Rodentia.

This exceedingly brief outline sketch will have served its purpose if it makes clear the wonderful character of the Santa Cruz fauna and its radical differences from the contemporary life of the northern hemisphere. Much remains to be done before the full account of these splendid collections can be published. I have attempted merely to describe their general nature and the impression which they make upon an observer whose studies have hitherto dealt with northern types.

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IS THERE ANY DISTINCTION BETWEEN SEXUAL REPRODUCTION AND ASEXUAL REPRODUCTION?

The following pages contain rather a full outline of the views advanced by Professor Richard Hertwig in a recent lecture* in which he discusses the relation between fertilization and reproduction. I have endeavored to make this more in the nature of an abridged and revised translation than a review, for it seemed best to follow as closely as possible Professor Hertwig's own way of presenting the subject, which is as follows:

Everyone will admit that most of our general conceptions in biology are greatly influenced by our knowledge of the higher animals and plants. This fact is made very evident to all who study the reproduction

* 'Mit welchen Recht unterscheidet man geschlechtliche und ungeschlechtliche Fortpflanzung?' Vortrag, gehalten am 7, November, 1899. Aus den Sitzungsberichten der Gesellschaft für Morphologie und Physiologie in München. 1899. Heft. II.

of Protozoa, and the inevitable conclusion from such study is that our schema of the kinds of reproduction needs reforming.

In common usage we distinguish the sexual multiplication of animals, in which the formation of the new individual is preceded by an act of fertilization, from the asexual multiplication which takes place without fertilization. The existence of parthenogenesis makes such a distinction difficult to maintain. We can no longer consider this phenomenon as the 'monogonous' method of reproduction, since the typical cases, which are found in the Arthropods, have apparently been derived from sexual reproduction by the loss of fertilization. The same is probably true of what occurs in the Sporocysts and Rediæ of the Trematodes. In order to overcome this difficulty and place parthenogenesis where it naturally belongs, I would propose for sexual reproduction the term *reproduction by means of germ cells*. But I would not stop with this alone, for my study of Protozoa has developed in my mind a strong conviction that our whole view of reproductiou needs a radical reformation.

Reproduction by the asexual method alone was formerly considered an important characteristic of the Protozoa, but this breaks down entirely in the face of the increasing number of observed cases in which true fertilization occurs. From the observations recorded for Ciliates, many Flagellates, Rhizopods of the most widely different orders and numerous Sporozoa, I believe that *fertilization occurs in all Protozoa*, and that its rarity and the difficulty of demonstration are the only reasons its general occurrence has not hitherto been observed.

A still further objection to the term *sexual reproduction* arises from the fact that *we often, if not generally, fail to discover any causal relation between fertilization and reproduction.* The actual reproduction of the Protozoa is accomplished either by their division into two or more individuals of equal size or by the pinching off of smaller daughter animals from a larger mother. Now, before we have a right to speak of reproduction as 'sexual,' we must show that fertilization exercises a determinative influence upon its course. This might be proved by showing that fertilization hastened reproduction or by showing that certain kinds of reproduction occurred only in connection with fertilization. Any such determinative influence is now positively excluded in a large majority of cases.

In the ciliated Infusoria, where fertilization in the Protozoa was first recognized as such and has been most carefully described, conjugation is not the forerunner but the after result of active reproduction. Conjugation is even a hindrance to the multiplication of Infusoria, because the necessary reconstruction of the nucleus often occupies many days, that are lost for the purpose of reproduction. The power of division of an Infusorian which has just finished conjugation is, if anything, less than before, and is never increased. In like manner, the power of division in an Infusorian is not decreased as it approaches the time of conjugation, for when two individuals are separated before the actual nuclear exchange has begun, they will divide even more actively than animals after the conjugation has been normally ended. In fine, one comes to the conclusion that the advent of conjugation in Infusorian cultures is not a favorable sign for their further increase.

Beyond any doubt, fertilization causes a pause in the multiplication of many Flagellates and Rhizopods. Volvox when fertilized yields resting spores, which will only develop after a long period, during which they have been frozen or dried.

The same thing is observed after the conjugation of Algæ, with which *Volvox* is quite rightly placed by most investigators.

The cyst of *Actinophrys sol*, which arises during fertilization, has exactly the same significance. In *Actinosphærium eichorni* the encystment is connected with multiplication, but the multiplication (making of the primary and secondary cysts) precedes fertilization, and the fertilization itself (fusion of the secondary cysts) leads to a resting period of considerable duration (making of the germ spheres).

In the Protozoa then *a lessened power of division follows upon fertilization.* In many Gregarines encystment is certainly accompanied by fertilization, for the division into pseudo-navicellæ, which in turn separate into the sickle-shaped germs, begins within the cyst. In the Gregarines proper, multiplication seems to be restricted entirely to this encysted condition. In some Sporozoa, on the other hand, there are two kinds of division. Coccidiæ and Hæmosporidiæ multiply in the tissues of their hosts by division and without fertilization (auto-infection). At length, however, peculiar divisions begin which are characterized by two things, (1) that they are prepared for by fertilization and (2) that the transportation from one host to another is necessary for their proper course. The fertilization may be completed in the old host, but the multiplication is connected with the transportation into a new one or with some change of place. Since a regular cycle between division with and division without fertilization is here established and each kind of division has its peculiarities, we may speak of an alternation of generations as Schaudinn has done. Another illustration of alternation of generations would be the reproduction of *Noctiluca.* This form multiplies for a long time by ordinary fission. Cross-fertilization then takes place between two individuals, each of which produces a generation of zoospores, which in turn grow up to *Noctilucæ.* According to Schaudinn's description, *Trichosphærium sieboldi* is still another example.

The above *résumé* shows that in all the cases cited multiplication by division, and after a time the advent of fertilization, is constant. There is, however, the greatest diversity in the relation between fertilization and division. There are three possible cases, (1) the fertilization is the cause which stops the division (*Volvox, Actinosphærium, Actinophrys*), (2) the fertilization is the cause which brings about division of another sort which is often very rapid (*Noctiluca*), (3) the fertilization has no marked influence upon the power of division, because the same kind of division prevails after fertilization as before.

In view of these facts is it possible to speak of 'sexual' reproduction in the Protozoa? I think we cannot use such a designation without causing false conceptions of the relation between reproduction and fertilization. There exists in the Protozoa only one kind of reproduction, *i. e.*, division in its manifold varieties. Besides this the Protozoa need to reorganize the structure of their unicellular bodies by fertilization. What the nature of this reorganization is, or its physiological significance, I will not attempt to discuss.

Fertilization is thus interposed from time to time in the life history of a Protozoan. The life epoch at which this interposition occurs is often connected with the times of more subordinate importance. It depends upon suitable conditions which always vary according to the conditions of life in the different classes and orders and perhaps even in the families of the same order. In many Protozoa division takes place within the cyst in a manner somewhat similar to what occurs without the cyst in others. Since we attribute no great significance to these differences in encystment, so it would be a mistake to emphasize the question whether the division of a Protozoan was or was not brought into close connection with fertilization. In the Protozoa fertilization exercises no influence upon the power of multiplication which in any wise differs from the influence exerted by any other vital process of the cell. Fertilization and reproduction are phenomena which may be found together, but which in their essence have no connection with one another.

Leaving the Protozoa, I will now consider the kinds of reproduction in the Metazoa. We formerly supposed that the asexual reproduction of Metazoa had been inherited from the Protozoa and that their sexual reproduction was a new acquisition. This theory prevailed as long as we thought the Protozoa could only reproduce in an asexual manner. The wide distribution of fission and budding in the lower Metazoa and its entire absence in the Molluscs, Arthropods and Vertebrates, seemed to harmonize with such a view. Although I once held this same opinion, I now consider it incorrect. It seems to me much nearer the truth to make just the opposite statement, viz., that the sexual reproduction of Metazoa is a continuation of the method of reproduction in the Protozoa, while the budding and fission of Metazoa are adjustments having only an outward resemblance to the budding and fission of the Protozoa.

If we consider the multicellular animal as a cell community, its life history may be resolved into a series of innumerable cell divisions which were preceded by an act of fertilization. This is the same kind of developmental cycle as we find in many Protozoa. For example, in the Gregarines the formation of the pseudo-navicellæ and later the sickle-shaped germs follow fertilization. The sickle-shaped germ is comparable with the egg cell, for the Gregarine arising from it suspends multiplication until it has been fertilized. A different character would result in the Metazoa, from the fact that most of the products of division remain united and only certain ones, the sex cells, become self-sustaining. While every cell-division in the Protozoa is a similar act of reproduction, we now distinguish between cell-divisions which bring about the growth of existing individuals and those which permit the creation of new individuals. There is a further difference. The cells which effect the growth and life functions of the multicellular organism, the somatic cells of Weismann, have an enormous power of multiplication. The sex cells which are differentiated sooner or later differ from these proliferating cells in that they lose their power of division relatively early. Their characteristic maturation processes are the last expression of this power. The need of fertilization does not necessarily result from multiplication because the sex cells stop multiplying much sooner than the somatic cells which they closely resemble in all other respects. The cell community needs the combination of different kinds of idioplasm and therefore has seized the opportunity which is presented when the organism is in a unicellular state.

Our conclusion here is similar to that reached in the Protozoa. The occasional mingling of two idioplasms is necessary for the integrity of the cell's life and this is fertilization in the narrower sense. A second phenomenon may be associated with it, viz., the stimulus to development or reproduction. While in the Protozoa fertilization is now connected with reproduction and now separated from it, in the Metazoa it is always combined with reproduction. The two occur together as a necessary consequence of the multicellular condition, for a mingling of two idioplasms is possible only when the whole organism is contained in a single cell. We have thus fallen into the error of considering fertilization and reproduction inseparable. The recent investigations upon the details of fertilization have caused some of us to break away from this idea, but our opinion has not extended sufficiently to produce a general conviction that reproduction and the combination of idioplasms are separate phenomena.

To emphasize the difference between the two processes suppose we consider fertilization as a complicated morphological process, and reproduction as something which can be accomplished in another way. The first serves to unite substances which possess a stable organization. The second, like all cell-divisions, merely changes a physiological condition of equilibrium. Parthenogenesis is an example of how the power of development may be present in the absence of fertilization. My own view of this phenomenon is that the necessary reciprocal relations of nucleus and protoplasm are in some way established and division ensues. The so-called fertilization of non-nucleated egg-fragments seems to me an analogous case which no one who considers the nuclei the bearers of the idioplasm can call true fertilization. It is much more likely that the necessary reciprocal relation is established by a fusion of the egg-plasm with the plasma of the spermatozoan, in which event we should be dealing with a counterpart of parthenogenesis.

It would therefore be entirely conceivable that the conditions necessary to division could be produced in ripe unfertilized eggs by chemico-physical influences. Loeb's observation that the eggs of sea-urchins (*Arbacia punctulata*) develop to plutei if they have been previously exposed to the action of a certain salt solution, raises no theoretical objections to this view. I have myself succeeded in making unfertilized eggs develop after treatment with chemical reagents (strychnine), although they possessed the power of development to a lesser degree.

It would be of the greatest interest to trace the sexual reproduction of the Metazoa from its origin in the reproduction of unicellular forms. Unfortunately the solution of this problem is made the more difficult by the wide gap which separates the Protozoa and the Metazoa. The Mesozoa are not suitable for our purpose. Their development is not sufficiently known and has probably been modified by the entire class having become adapted to a parasitic life. Nevertheless the investigations upon the best known Dicyemidæ give strong indications that their reproduction still follows the method of the Protozoa. The endoderm of *Dicyema* produces reproductive cells which in many cases yield young animals directly, in others probably after previous fertilization. The first process serves for auto-infection; the last probably occurs when the parasite would be carried to a new host. The first is known in an entirely arbitrary way as parthenogenesis, when the criterion of parthenogenesis (loss of fertilization) is not proved. It evidently corresponds to the so-called asexual reproduction of the Protozoa. When their multicellular condition and the modifications which it entails are considered the development of the Dicyemidæ seems to admit of a very close comparison with the development of the likewise parasitic Coccidiæ and Hæmosporidiæ.

Plants offer a much more favorable field for the solution of this problem than animals because they exhibit many forms midway between the uni- and multicellular organisms. In the multicellular Algæ there are two kinds of reproduction: (1) asexual, by means of spores and (2) sexual by means of gametes. Both have in common the fact that single cells separate from the cell community and grow up into new plants. In the first case it is each time a single cell for itself, in the second a cell which has previously copulated with one of a different stock. The difference between spores and gametes is often quite pronounced both in their structure and their method of development. In other cases the anatomical and developmental differences are wiped out. It sometimes happens that cells which are in every other way like gametes develop without fertilization, if they are prevented from copulating. This seems to be analogous to the gradation in the need of fertilization which is found in the Protozoa. We are further reminded of the Protozoa by the fact that fertilization often leads to the formation of resting spores.

If we now attempt an accurate statement of the kinds of reproduction in the plant and animal kingdoms, the old conception of sexual and asexual reproduction must be given up entirely and replaced by the following statement.

All organisms effect their reproduction in a common way by means of single cells which have arisen by cell-division. In single-celled organisms every cell-division is an act of reproduction and results in the formation of another physiologically self-sustaining individual. In multicellular animals, most of the cell divisions lead to the growth of the multicellular individual and only certain of them serve for reproduction. Fertilization goes on side by side with reproduction, because the organism cannot attain its highest development without the union of two individualities by nuclear copulation. Fertilization in its essence has nothing to do with reproduction. In many single-celled organisms the two occur quite independently and are united for what we call sexual reproduction only under special conditions. Such special conditions are imposed upon all multicellular animals, since a mixture of two idioplasms could be easily accomplished only during the unicellular stage. Hence fertilization takes place when the single-celled reproductive bodies are formed. It in no wise follows that all such reproductive bodies must be fertilized. One would naturally expect that reproductive cells not needing fertilization (spores) and such as are destined for fertilization (gametes, eggs, spermatozoa) should exist side by side. This is the case in plants, though in multicellular animals no genuine case of spore-formation has been demonstrated beyond question.

The one case which can be pointed to with strong probability is the above mentioned reproduction of the Dicyemidæ. Everywhere else in the Metazoa spore formation seems entirely supplanted by sexual reproduction. All cases of development from single unfertilized eggs are apparently parthenogenesis and to be explained as sexual reproduction in which fertilization has been lost. The significance of heterogenesis in the di-genetic Trematodes is doubtful. In accordance with the prevailing view, I make a sharp distinction between spore-formation and parthenogenesis resp., heterogenesis, between reproduction by single cells which never have been fertilized and reproduction by cells in which the fertilization has been lost. I doubt if such a distinction could be practically carried out in every case. As long as the reproductive cells are developed in special germinal glands, as for example in the Crustacea, there can be no doubt that we are dealing with parthenogenesis. It is quite different, however, where no egg-glands are differentiated, as in the Rediæ and Sporocysts of the Trematodes. In such cases only a more accurate study of the first stages of development will elucidate the matter. In all cases of parthenogenesis which have been carefully investigated the maturation has been preserved. This has hitherto been always regarded as the forerunner of fertilization. Even in the Protozoa it is connected with the sexual process. Its existence in reproductive cells which develop without fertilization therefore favors the view that fertilization formerly did take place. On the other hand, one would suppose that spore-formation, like the ordinary division of the Protozoa, is without polar bodies. Unfortunately we can only speculate upon this exceedingly interesting question, for so far as I know the literature, not one case of spore-formation has been carefully investigated and most cases of parthenogenesis insufficiently. And yet such investigations, particularly in the lower plants and animals, would be a profitable and important work.

In my summary I have not mentioned the budding and the fission of the multicellular animals and the so-called 'vegetative reproduction' of plants. We commonly unite these processes with the budding of the Protozoa and the spore-formation of the Algæ, under the name of asexual reproduction. I have considered them only briefly as new acquisitions of multicellular organisms. In 'vegetative reproduction' whole multicellular stocks are set free from a mother animal which has rapidly increased in size. The phenomenon presents the greatest diversity. The budding of the Tunicates is quite different from that of the Bryozoa or Hydroids or from the fission of the Annelids. The diversity in the forms of vegetative reproduction is still greater in plants. The investigations in the past twenty years have also proved that the division and budding of the Metazoa do not follow the laws laid down by the germ layer theory. In this respect they resemble regeneration. The whole matter will be a self-evident phenomenon if we accept the view of reproduction which I have set forth above and recognize in the division and budding of the multi-cellular animals adaptive phenomena which have come about in the several groups independent of their development. These processes of asexual reproduction are well named by the botanist 'vegetative reproduction.' If they are more common in the lower than in the higher forms it is because the higher organization sets a limit to the vicarious substitution of one part for another. Similar conditions therefore underlie vegetative reproduction and regeneration and there are many analogies between the two processes. It is worth noticing that in the lower plants, where spore-formation is very common, 'vegetative reproduction,' if we use the term as we have just defined it, is not present. Stocks which have been accidentally broken off from the threads of Algæ can, it is true, develop further, but under natural conditions the Algæ seldom make use of the process for reproduction.

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*STUDY OF THE CORRELATION OF THE HUMAN SKULL.**

THE substance of this paper was a thesis for the London D.Sc. degree; it was shown to Professor Pearson, at whose suggestion considerable modifications were made, and a revision undertaken with a view to publication.

In order to deal exactly with the problem of evolution in man it is necessary to obtain in the first place a quantitative appreciation of the size, variation and correlation of the chief characters in man for a number of local races. Several studies of this kind have been already undertaken at University College. These fall into two classes, (i) those that deal with a variety of characters in one local race, and (ii) those which study the comparative value of the constants from a variety of races. Thus Dr. E. Warren has dealt with the long bones of the Naqada race,† Mr. Leslie Bramley-Moore has compared the regression equations for the long bones from a considerable number of races in a memoir not yet published, Professor Pearson has dealt with the regression equations for stature and long bones as applied to a

* 'Data for the Problem of Evolution in Man,' No. VI. By Alice Lee., D.Sc., with some assistance from Karl Pearson, F.R.S. Abstract read before the Royal Society of November 15, 1900.

† *Phil. Trans.*, B, Vol. 189, p. 135.

variety of races;* Miss A. Whitely has studied the correlation of certain joints of the hand,† and is investigating the correlation of the bones of the hand in a second local race; Miss C. D. Fawcett has made a long series of measurements on the Naqada skulls, and correlated their chief characters; the present memoir, on the other hand, deals with only a few characters, in the skull, comparing, however, the results obtained from a variety of local races.

It is thus related to Miss Fawcett's work much as Mr. Bramley-Moore's to Dr. Warren's, *i. e.*, it endeavors, by selecting a few characters and testing them, to ascertain how far results obtained for one local race are valid for a second. In Professor Pearson's memoir on the reconstruction of the stature of prehistoric races, results obtained from one local race were then extended to a great variety of other races. The degree of accuracy in this procedure can only be fully ascertained when the data now being collected in both English and German anatomical institutes are available for calculation.

The skull, however, differs very widely from the stature and long bones; for while these have a very high degree of correlation in all local races, the chief characters of the skull are very loosely correlated, and such correlation as they possess varies in a remarkable manner with sex and race. This was first indicated by Professor Pearson;‡ it has been amply illustrated in the measurements of Miss Fawcett, and is confirmed in a recently published memoir by Dr. Franz Boas. It may be said that this want of correlation in the parts of the skull is the origin of its great importance for the anthropologist; it is the source of its personal and racial individuality. But this anthropological advantage, is, from the standpoint of organic evolution, a great disadvantage. Cuvier introduced the conception of correlation with the idea of reconstructing from a single bone the whole skeleton and even the outward form of an extinct animal, but the great want of correlation between the parts of the skull, and between the skull and other parts of the human skeleton, renders quantitative reconstruction — and this is the really scientific reconstruction —of one character of the skull from a second, or of the skull and parts of the skeleton from each other extremely difficult, if not impossible, for all but a very few characters.

Among these characters one of the most feasible to deal with, and one of the most useful, is the capacity of the skull. This is correlated to a fairly high degree (although to nothing like the same extent as the long bones among themselves) with the maximum length and breadth, with the total and auricular heights, and with the horizontal and vertical circumferences of the skull. The present memoir deals in the main with the problem of the reconstruction of the capacity from these characters.

Three fundamental problems arise in the theory of reconstruction, *i. e.*, the determination of the probable value of an unknown character from a known and measurable one, or from several such. Namely:

I. The reconstruction of the individual from data for his own race.

II. The reconstruction of the average value of a character in one local race from data determined for a second local race.

III. The determination of the probable value in an individual of characters not measurable during life from characters which are measurable.

These three problems are all dealt with for the special character capacity of the skull in the present paper. Their impor-

* *Phil. Trans.*, A, Vol. 192, p. 169.

† *Roy. Soc. Proc.*, Vol. 65, p. 126.

‡ *Phil. Trans.*, A, Vol. 187, p. 279, and *Roy. Soc. Proc.*, Vol. 60, p. 495.

tance may be indicated by the following considerations:

(*a*) Many, especially of the more ancient and accordingly of the more interesting skulls, are too fragile or too fragmentary to allow of their capacity being directly determined.

(*b*) The methods for directly determining capacity are still not only very diverse, but divergent in result, and from the physical standpoint, crude and inexact. In the concordat of the German craniologists—the *Frankfürter Verständigung*—the point was left for future consideration, and so it has remained for many years. The capacities of series of skulls determined during the past forty years in France, England and Germany are, we are convinced, not comparable, at least if the argument from the comparison is to depend on a difference of 30 to 40 cm.^{3} While the same observer using different methods may be trained to get results within 4 to 6 cm.^{3} for the same skull, different observers, equally careful, using the same method, will easily get results for the same series diverging by 20 to 30 and even more cubic centimeters. Shortly, the personal equation—involved in the packing in the skull and in the measuring vessel—is very large.

Accordingly a regression equation for the capacity as based on external measurements may, if deduced from a sufficiently large range of series measured by careful independent observers, give results fairly free from the error of personal equation and this sensibly as correct as, or more correct than, direct measurement when we require the mean capacity of a series.

(*c*) It is impossible to obtain a large series of skulls belonging to known individuals with a classified measure of intellectual ability. Actually we have only a few skulls of men of great intellectual power, sometimes preserved because they were large, and to compare with these the skulls of the unknown and often the ill-nourished, which reach the anatomical institutes.* Accordingly it is an investigation of considerable interest to compare the *probable* capacity of the skulls of living persons with their roughly appreciable intellectual grade. It is only by such a comparison that we can hope to discover whether the size and shape of the skull is to any extent correlated with brain power.

In the course of the memoir it is shown that the auricular height of the skull is a better measurement for determining skull capacity than the total height; that the circumferences of the skull, while highly correlated with its capacity, give regression equations which vary widely from one to another closely-allied race; that linear regression equations involving length, breadth and auricular height, while giving fairly good results for individuals within the local race, have very divergent coefficients as we pass from local race to local race; that the cephalic index has very little correlation with capacity at all; as a rule what there is may be summed up in the words: In a brachycephalic race the rounder the skull the greater the capacity, in a dolichocephalic race the narrower the skull the greater the capacity—the greater capacity following the emphasis of the racial character; finally, that the correlation of capacity with the triple product of length, breadth and height gives a regression equation which is fairly constant from local race to local race, and is accordingly the best available.

From this and other equations individual and racial reconstructions are made, and the deviations between the actual and predicted capacities in randomly chosen series of skulls are tabulated. The mean error made in the reconstruction of the individual capacity by the best formulæ is 3 to 4

* This argument applies also, in even an intensified degree, to the determinations of brain weight.

per cent., the maximum error, although of course infrequent, may even be ten per cent. For the reconstruction of the mean capacity of a race, the mean error is about 1.2 per cent., with a maximum error of 2.5 per cent. If these errors appear large to the craniologist, we would remind him that his search for an absolutely correct formula giving cranial capacity from external measurements is the pursuit of a will o' the wisp. The theory of probability shows us exactly the sort of errors such formulæ are liable to, and teaches us how to select the best. The whole basis of the theory of evolution, the variability of one character, even with fixed values for a number of others, would be upset if any such absolute formula were forthcoming. What we have to do is to select a few organs as highly correlated as possible, but, having done this, it has been shown elsewhere that we shall not sensibly decrease the error of our prediction by increasing the number of organs upon which the estimate is based.* Accordingly we do not believe that sensibly better reconstruction formulæ than those found will ever be forthcoming, for, as we have already observed, we know from Miss Fawcett's wide series of skull correlations that we have practically chosen the organs of the highest correlation. Better data for determining the equations will undoubtedly be available as further craniological measurements are made, or as the great mass already made are quantitatively reduced.

In the last place we turn to the third problem: the reconstruction of the capacity of the living head. The memoir contains tables of the skull capacity of some sixty men, and also of some thirty women, whose relative intellectual ability can be more or less roughly appreciated. It would be impossible to assert any marked degree of correlation between the skull capacities of these individuals and the current appreciation of their intellectual capacities. One of the most distinguished of continental anthropologists has less skull capacity than 50 per cent. of the women students of Bedford College; one of our leading English anatomists than 25 per cent. of the same students. There will, of course, be errors in our *probable* determinations, but different methods of appreciation lead to sensibly like results, and although we are dealing with skull *capacity*, and not brain weight, there is, we hold in our data, material enough to cause those to pause who associate relative brain weight either in the individual or the sex with relative intellectual power. The correlation, if it exists, can hardly be large, and the true source of intellectual ability will, we are convinced, have to be sought elsewhere, in the complexity of the convolutions, in the variety and efficiency of the commissures, rather than in mere size or weight.

* *Phil. Trans.*, A, Vol. 190, p. 466.

AMERICAN ORNITHOLOGISTS' UNION.

THE Eighteenth Congress of the American Ornithologists' Union convened in Cambridge, Mass., Monday evening, November 12th. The business meeting was held in Mr. William Brewster's Museum, and the public sessions, commencing Tuesday, November 13th, and lasting three days, were held in the Nash lecture room of the University Museum.

Dr. C. Hart Merriam, of Washington, D. C., was elected President; Charles B. Cory, of Boston, and C. F. Batchelder, of Cambridge, Mass., Vice-Presidents; John H. Sage, of Portland, Conn., Secretary, and William Dutcher, of New York City, Treasurer. Frank M. Chapman, Ruthven Deane, E. W. Nelson, Witmer Stone, Drs. A. K. Fisher, Jonathan Dwight, Jr. and Thos. S. Roberts were elected members of the Council. By a provision of the by-laws, the Ex-Presidents of the Union, Dr. J. A. Allen and Messrs. William Brewster, D. G. Elliot and Robert Ridgway are *ex-officio* members of the Council.

One honorary, two corresponding and seventy associate members were elected.

A change in the by-laws was proposed whereby the present class of active members shall be known as fellows; the present class of associate members to be known as associates, and to establish a class of membership intermediate between fellows and associates, to be known as members. The matter will be brought up for final action at the next Congress of the Union.

Miss Juliette A. Owen, of St. Joseph, Mo., an associate member, who so kindly remembered the Union at the last Congress, sent an additional $100 this year. This will be added to a fund, the income of which is to be used for the advancement of the science of ornithology.

An address in commemoration of Dr. Elliott Coues, a distinguished member, and a former president of the Union, who died since the last Congress, was delivered by Professor D. G. Elliot. Dr. Coues became eminent in science, and did more perhaps than any other person to stimulate in young people an interest in birds. Dr. J. A. Allen presented a memorial address on the Hon. Geo. B. Sennett, an active member of the Union, who died during the past year. Mr. Sennett, although deeply engrossed in business, never lost his taste for ornithology. His writings relate mainly to the birds of Texas.

The report of the Committee on Protection of North American Birds, read by its Chairman, Mr. Witmer Stone, showed that satisfactory results had been obtained during the past year. One important feature was the protection of the gulls and terns along the coast, made possible by money secured through the efforts of Mr. Abbott H. Thayer. Mr. William Dutcher, who had special charge of this phase of the work, made a supplementary report, giving in detail the localities where the birds were found and eventually saved. These reports will be published in *The Auk*, and reprinted as a separate pamphlet, to be sold at a very low price for general distribution.

Judge John N. Clark's 'Dooryard Ornithology' was a popular and well presented paper. Mr. Clark lives in Saybrook, Conn., and in the restricted area about his house he has noted the occurrence of more than one hundred species of birds.

From letters written to the late Spencer F. Baird, Mr. Witmer Stone was able to obtain, by courtesy of Miss Lucy H. Baird, interesting facts about many of the older ornithologists. These he embodied in an important historical paper called 'The 'American Ornithologists' Union' of 1840–45.' It is difficult to realize at the present time the discomforts and disadvantages that confronted workers in any science sixty years ago.

Two afternoons were devoted to papers illustrated by lantern slides—all showing what an aid photography now is to the study of the habits of birds.

Following is a list of the papers read at the sessions in addition to those already mentioned:

'The Sequence of Moults and Plumages of the *Laridæ* (Gulls and Terns)': JONATHAN DWIGHT, JR.

'A Study of the Genus *Sturnella*': FRANK M. CHAPMAN.

'The Pterylosis of Podargus; with Further Notes on the Pterylography of the *Caprimulgidæ*': HUBERT LYMAN CLARK.

'The Moult of the North American Shore Birds (*Limicolæ*)': JONATHAN DWIGHT, JR.

'Nesting of the Yellow-headed Blackbird.' Illustrated by lantern slides: THOMAS S. ROBERTS.

'Among the Terns at Muskeget, and on the New Jersey Coast.' Illustrated by lantern slides: WM. L. BAILY.

'The Season of 1900 at the Magdalen Islands; with remarks on bird photography.' Illustrated by lantern slides: HERBERT K. JOB.

'Field Notes on a few New England Birds.' Illustrated by lantern slides: WILLIAM BREWSTER.

'Notes on the Spring Migration (1900) at Scarborough, N. Y.': LOUIS AGASSIZ FUERTES.

'Impressions of Some Hawaiian Birds': H. W. HENSHAW.

'A Visit to the Birthplace of Audubon': O. WIDMANN.

'Natural History of the Alaska Coast.' Illustrated by lantern slides: C. HART MERRIAM.

'Notes on a Nest of Massachusetts Brown Creepers.' Illustrated by lantern slides: A. P. CHADBOURNE.

'Bird Studies with a Camera.' Illustrated by lantern slides: FRANK M. CHAPMAN.

'Aptoschromatism.' A reply to Drs. Dwight and Allen: FRANCIS J. BIRTWELL.

'On the Breeding Habits of Leconte's Sparrow': P. B. PEABODY.

'On the Valne of Careful Observations of Birds' Habits': EDWARD H. FORBUSH.

'Breeding of the Cerulean Warbler near Baltimore': FRANK C. KIRKWOOD.

'The Enforcement of the Lacey Act': T. S. PALMER.

The next annual meeting will be held at the American Museum of Natural History, New York City, commencing November 11, 1901.

JOHN H. SAGE,
Secretary.

*THE WELSBACH LIGHT.**

THE Franklin Institute of the State of Pennsylvania for the Promotion of the Mechanic Arts, acting through its Committee on Science and the Arts, investigating the merits of the Welsbach Light, which was referred to the Committee by the Jury of Awards of the late National Export Exposition, 1899, reports as follows:

The procuring of artificial light by some means other than using the flame of burning carbonaceous material in the ordinary candle, lamp or gas burner has been the aim of many investigators. As a result of this endeavor, we find on the one hand lamps in which carbon is heated to a point where it gives off light—or becomes incandescent—as by the passage of an electric current through an incandescent filament or arc lamp crater; or, on the other hand, lamps in which the incandescence of certain substances (oxides of certain of the elements for the most part) is produced by the application of a heating flame or the passage of an electric current to raise their temperature. Of these latter burners, the development of those using a heating flame applied to produce incandescence of rare earths is the particular thing dealt with in this report, but it seems impossible to avoid a mention of others when giving an outline of the chain of discoveries and inventions leading up to the Welsbach light of to-day.

It is probable that Drummond is one of the earliest discoverers of the fact that heated oxides of certain elements incandesce. Certainly he made the first practical application of the fact. Every one knows of the Drummond or lime-light which has been so commonly used in the projection lantern. A piece of lime, or better, a piece of oxide of magnesium, or, most refractory of all, a piece of oxide of zirconium, has an oxyhydrogen flame play upon it and is thereby heated to a temperature at which it incandesces and gives off an intensely-bright white light. Lieutenant Thomas Drummond, in the English government service, made this discovery in 1826, and used it in connection with his heliostat in surveying work, and afterwards proposed the same arrangement for lighthouse service.

In 1868, Le Roux, Professor at the École Polytechnique, Paris, discovered that a brilliant incandescent light might be procured from a rod of lime or magnesia, by heating it until an electric current passes, this afterward maintaining the light.

In 1879, Jablochkoff patented the use of a piece of kaolin as a source of light, making it incandesce by passing an electric cur-

* Being the report of the Franklin Institute, through its Committee on Science and the Arts, on the exhibit of the Welsbach Light Company, of Gloucester City, N. J., referred by the Bureau of Awards of the National Export Exposition. Sub-Committee.—Arthur J. Rowland, Chairman; C. A. Hexamer, Wm. McDevitt, Frank P. Brown, Moses G. Wilder.

rent through it. He had noticed that the kaolin he had placed between the carbons of his arc lamp assisted the illumination.

These inventions show something of the development of knowledge regarding materials which might be made incandescent, and the means taken to make them incandesce.

Several years later, in 1881, W. M. Jackson (an American) invented the device of a lamp made of platinum, iridium or other materials non-oxidizable at high temperatures, in the form of wires of small section which were heated to incandescence by the use of a heating flame. He discovered that the finer his wires, the more intense the light produced. Here is a beginning of a mantle light.

In 1881, Charles M. Lungren, of New York, patented in the U. S. Patent Office an improvement in illuminating apparatus, which consisted in passing a non-luminous gas flame through a heater of clay or similar material highly heated by jets of the non-luminous gas, and forcing atmospheric air through the heater and causing it to mingle with the non-luminous gas issuing in one or more jet flames against lime, magnesia, zirconia or similar material, producing incandescence.

In the same year (1881) Mr. Lungren filed an application in the Patent Office for a means of illumination which consisted in forming a filamentary body of refractory material, said body having the structural form necessary to envelope a gas flame and to be rendered incandescent by such flame.

This application, after allowance by the Patent Office, was permitted to lapse, and no patent was then issued.

Mr. Lungren, however, renewed his application in August, 1885, and the patent, which embodied improvements upon his unissued patent of 1881, was issued July 5, 1887 (No. 365,832). Subsequently, a second patent (No. 367,534), describing specific features of his incandescent lighting method, was issued to Lungren under date of August 2, 1887.

In the first of these patents Lungren describes his method of making refractory filaments for lighting composed of 'lime, magnesia, zirconia, etc.,' by preparing a plastic mass of these materials, or mixtures of them by kneading them with water, or preferably, a solution of a mucilaginous binding material, such as glue or gum, or other combustible material which will be consumed in the further treatment of the filament. When the mass is of the proper consistence, it is put in a press and the filament is obtained by expressing the material through a die. Immediately after their formation, and while still moist, the filaments are formed up into various shapes desired by bending or coiling over a mandrel of wood coated with plumbago, or other device, and then dried, when they are ready to apply to a support and to be used in connection with a gas flame, in substantially the same manner as the well-known Welsbach mantle.

The Lungren incandescent lighting system was the subject of investigation by the Committee on Science and the Arts of the Franklin Institute in 1891. Prolonged practical tests of the Lungren filaments showed that they possessed unusual life duration in service, with satisfactory lighting quality; and the award of the John Scott Legacy Premium and Medal was made to the inventor.

For reasons unknown to your committee, this promising invention was never commercially exploited.

The next year (1882) a Frenchman, Charles Clamond, invented a lime light operated without oxyhydrogen flame by intensely heating the air used and directing the flame of his air and gas mixture against the refractory oxide chosen. He knew of the possible use of certain other metallic oxides to produce an incandescent light, and even invented a basket or mantle of magnesia threads, supported in an enclosing platinum mantle of small wire and large mesh, which was hung below the lamp and the heating flame directed down into it. The threads were made from magnesia which was calcined and pulverized, then made plastic by mixing with salts of magnesia, which may be afterwards decomposed by heat, then squirted through a die, woven into a basket form and dried and baked.

In 1885, Otto B. Fahnehjelm, a Swedish inventor, secured an American patent (see U. S. Patent No. 312,452, February 17, 1885) for an incandescent light which consisted in the combination with a suitable gas burner and a shade holder of means for suspending an incandescent body in the flame of the burner, and for adjusting the incandescing body horizontally and vertically in relation to the flame. The Fahnehjelm light consisted substantially of a series of rods of calcined magnesia, resembling the teeth of a comb, held in a suitable frame and suspended in a non-luminous flame of gas.

In 1886, Galopin and Evans (in Australia) produced a lamp burning hydrocarbon vapor mixed with air to produce a heating flame, directed downwards into a woven platinum mantle, which was thus made incandescent.

About this same time, or even a little earlier (1885), Carl Auer von Welsbach announced the invention of a lamp in which the rare oxides of lanthanum, yttrium, zirconium, etc., in a finely divided condition, were rendered incandescent by heating to a high temperature. The source of light was a light network of cotton thread impregnated with a solution of the salts of the combined nitrates, oxides or bromides. After being saturated with these, upon exposure to heat, the supporting cotton network was burned out, the salts converted into the oxides and a skeleton hood or cap thus prepared, which would incandesce when a heating flame was applied to it.

The absolute originality of this form of mantle and method of manufacture should be carefully noted.

The nitrates of the metals, being very soluble, were especially adapted to the process, although sulphates, iodides or bromides could also be used.

Welsbach found that this mantle, as it came to be called almost from the first, could resist the action of all atmospheric air fit to breathe for an indefinite length of time, was not changed by exposure and would remain effective for a long time.

For the next five years or more von Welsbach was constantly at work making elaborate investigation of the properties of all oxides of metals which would incandesce when used separately, and when combined in various mixtures. He invented processes whereby the salts of the metals required for impregnating mantles might be prepared from the natural ores, originated means for strengthening the frail mantle, arranged the mantles for transportation in safety, and perfected many details making the lamp practical.

It is interesting to notice that the form of mantle and the general process of manufacture have remained up to the present precisely as von Welsbach originally planned them, without improvements or essential modification of any kind.

One or two of the discoveries of von Welsbach are necessarily mentioned a little in detail, to explain the magnitude of the investigations he conducted and the sort of results he procured.

A patent No. 409,531, August 20, 1889, explains that the illuminating power is greatly increased by adding thorium oxide; that lanthanum oxide without sufficient thorium oxide crumbles when incandescent—with it the mantle becomes flexible. Later he found (patent No. 563,524) that thorium oxide, by the addition of a small per cent. of uranium or cerium oxide, has a very high illuminating power, producing a vivid and nearly white incandescent light, in spite of the fact that thorium oxide alone radiates little light which is yellow in color, and that uranium oxide alone radiates little light, and it is yellow reddish. Still later, he discovered that the illuminating power of lanthanum, cerium, yttrium, zirconium and other metals of the refractory earths is greatly increased by the addition of thorium oxide (ThO_2); that cerium not only gives a yellow light (very desirable color), but greatly increases the life of the mantle, causes it to hold its shape better, and makes it in every way stronger and more durable.

Thus we get a slight idea of the elaborate researches conducted by Dr. von Welsbach, and of the many difficulties which had to be overcome before the Welsbach mantle could become practical and commercial.

To complete the story of lights procured by the incandescence of metallic oxides, mention should be made of the lamp invented by Professor Walther Nernst, of the University of Göttingen, early in 1899, the substance rendered incandescent being a magnesia rod through which an electric current is passed after preliminary heating. Not only is this light related to the same group as the Welsbach, not only does it give a very modern illustration of a sort of lamp mentioned earlier in the report, but (most interesting of all) in his latest work Nernst gives up the magnesia and uses the same mixtures of oxides as used in the Welsbach mantle — zirconium, thorium, cerium, erbium, etc.

A very brief description of the lamp and mantle made for use with illuminating gas by the Welsbach Light Company, of Gloucester, N. J., will give the best idea of present methods, and serve to bring out some important points with reference to the light-giving power, durability and economy of the mantle as put on the American market. The Welsbach 'J' mantles (standard until very recently) were made about as follows: A six-cord cotton thread was woven on a knitting machine forming a tube of knitted fabric of rather open mesh. This web has the grease and dirt thoroughly washed out of it, is dried, then cut into lengths double that required for a single mantle. It is then saturated in the fluid (described later), wrung out, stretched over spools and dried. Next, the double length pieces are cut into two, the tops of each piece doubled back and sewed with a platinum wire which draws the top in and provides a means of supporting the mantle when finished from the wire holder. After stretching the mantle over a form, smoothing it down and fastening the platinum wire to the wire mantle holder, the mantle is burned out by touching a Bunsen burner to the top. The cotton burns off slowly, leaving a skeleton mantle of metallic oxides, which are unconsumed, and which preserve the exact shape and detail of every cotton fiber. The soft oxides are then hardened by a Bunsen flame. During burning out and hardening, considerable shrinking takes place. This finishes the process, except the immersion of the mantle in crystalline, to prepare it for transportation, after which it is trimmed and packed. The fluid in which the cotton webbing is immersed is procured from monazite sand, which yields in the finished mantle oxides of thorium and cerium.

The candle-power of mantles of the sort mentioned is about 75 initial candle-power under gas pressure of Philadelphia illuminating gas. This means 20 candles per cubic foot per hour (an ordinary 8-foot fish tail burner gives not over three candle-power per cubic foot per hour). The life of the mantles is probably not much below 1,000 hours. The candle-power drops quite rapidly at first and more gradually afterwards, going as low as to one-half the initial candle-power before the mantle breaks.

It is hard to tell how much the perfection of detail in burner construction, a proper selection of chimney, and artistic features of design have contributed to procure the very large commercial use of the lamps. Without proper burners the mantle would be of small value. The details of the common burner, the peculiarities of which make it different from the ordinary Bunsen burner in adjustment of gas and air; the gauge distributing device to spread the flame over the whole mantle and so fill the mantle are too well known to merit detailed description.

The mantle first made in America, in 1888, gave only 35–40 candle-power initial, under 10/10 pressure, using 3 to 3.2 feet of gas on 3-inch mantles, and under ordinary conditions not over 8 candle-power per cubic foot of gas used.

The new mantle, known as Balm Hill or, popularly, 'Yusea' mantle, has a much more open mesh than the 'J' mantle, and is made on lace-making machinery. It is thus supposed to be much stronger than the older mantle, and gives about 100 initial candle-power at the mantle when the gas and air are properly adjusted in the burner. Your committee has been unable to gather data of life or decline in candle-power in time to include them in this report.

Certain defects in the mantle light should not be entirely passed over. The mantle is exceedingly fragile and cannot be made to stand where it is subject to continued vibration; the quality of the light is such as to require the adjectives cold, ghastly, harsh, in describing it; and often a greenish tinge in the light is evident. The candle-power drops badly early in the life of a mantle, and is especially subject to this trouble where there is much dust in the air; the oxides seem to volatilize slowly from the mantles, as evidenced by the shrinking in size of strands of mantle and the white deposit on chimney, for platinum melts easily in the part of the flame where the mantles hang.

If the mantle breaks, a hole being thus produced in it, the hot flame strikes out through this, often breaking the chimney, and as a secondary result destroying the mantle itself.

On the other hand, the advantages in the use of the mantle for lighting are shown not only by statements already made, but also by the fact that artificial lighting has been profoundly affected by the commercially-successful mantle. We have systems of lighting using mantles now in which the source of the heating flame is gas, gasoline, kerosene. There are systems using Welsbach mantles in which pressure of large amount, and others in which low pressure is used. There are two great companies, the Welsbach Commercial Company and the Welsbach Street Lighting Company, that do an enormous business and deal only with the use of the Welsbach mantle in lamps using ordinary illuminating gas.

The patents held in this country by the Welsbach Light Company are very broad and fundamental, and have to do with all sorts of details of the system as well. The numbers of the patents of most importance are given below.* Over fifty in all were

*359,524,	March	15,	1887.	Carl Auer von Welsbach.
377,698,	Feb.	7,	1888.	" " " "
377,699,	"	7,	"	" " " "
377,700,	"	7,	"	" " " "
377,701,	"	7,	"	" " " "
390,057,	Sept.	25,	"	Harold J. Bell.
396,347,	Jan.	15,	1889.	Carl Auer von Welsbach.
399,174,	March	5,	"	" " " "
403,803,	May	21,	"	" " " "
403,804,	"	21,	"	" " " "

submitted to your committee. Some of these are not to Welsbach, and yet are for processes of importance in the manufacture of the present American-made mantle and lamp.

In consideration of the enormous advance in the art of artificial lighting made possible by the invention of the Welsbach mantle, the Franklin Institute awards the Elliott Cresson Medal to Dr. Carl Auer von Welsbach, of Vienna, Austria, for his discoveries regarding the metallic oxides which may become incandescent when heated, and for the invention of a mantle by the use of which these metallic oxides are commercially available as sources of artificial light.

Also, in view of the many details wrought out by the Welsbach Light Company, of Gloucester, N. J., in putting a thoroughly practical mantle on the market, the Franklin Institute awards to them, the said company, in addition, the Edward Longstreth Medal of Merit.

UNIVERSITY REGISTRATION STATISTICS.

NOTWITHSTANDING the obscurities, frequent inaccuracies, and baldness of statement inherent in a table of comparative statistics, it is nevertheless believed that our readers will find some degree of interest in the accompanying summary of the statistics of registration at sixteen of the leading

	California.	Chicago.	Columbia.§	Cornell.**	Harvard.††	Indiana.	Johns Hopkins.
College (Arts) Men			464 (18)	746 (82)	1992 (90)	563 (15)	178 (3)
College (Arts) Women	2050(295)	975 (105)	292 (69)		448 (57)	268 (5)	
Scientific Schools*			540 (78)	880 (83)	507 (12)		
Law	121 (15)		427 (50)	176(—1)	647 (34)	110 (10)	
Medicine	171 (10)		751 (—6)	336 (8)	749 (36)		211 (0)
Agriculture				174 (11)			
Art	208 (37)						
Dentistry	152 (3)						
Divinity		180 (—3)			28 (1)		
Forestry				22 (3)			
Music							
Pharmacy	84 (2)						
Teachers College		499 (280)	344 (?)				
Veterinary	2 (0)			41 (12)			
Graduate Schools	20(—8)	330(—56)‡	383 (3)‖	192 (22)	393(15?)‡‡	40 (5)	159(—28)
Auditors			20 (—2)				
Courses for Teachers	†		721(—29)				
Summer Session	433(273)	1790 (154)	417 (417)	464 (40)	987(131)	333 (82)	
Other Special Courses							81 (26)
Deduct double registration			98°		64‡‡		
Grand Total	3221(635)	3774 (480)	4261 (555)°°	2458(218)	5720(382)	1280(137)	629 (1)
Officers	300	225	471 (28)		495 (47)	60	129

407,963, July 30, "	F. L. Rawson and W. Stepney Rawson.
409,528, Aug. 20, "	Carl Auer von Welsbach.
409,529, " 20, "	" " " "
409,530, " 20, "	" " " "
409,531, " 20, "	" " " "
438,125, Oct. 7, 1890.	" " " "
463,470, Nov. 17, 1892.	" " " "
563,524, July 7, 1896.	" " " "
26,075 (design), Sept. 22, 1896.	Geo. S. Barrows.

* Includes schools of engineering, chemistry, architecture and mines.

† Included in statistics of college and scientific schools.

‡ Includes 118 students in the 'Ogden Graduate School of Science.'

§ Statistics of November 7th.

‖ Not including 107 professional students who are also candidates for the degree of A.M. or Ph.D.

° Includes 74 Summer Session students who have returned for the fall term.

** Statistics of November 15th.

†† Statistics of November 19th.

‡‡ Includes 52 graduate students in Radcliffe, which number is deducted for double registration.

universities in the United States. Unless otherwise indicated, these statistics represent the registration at the respective universities on November 1, 1900.

Variations in the standard of admission and of required work, in the interpretation of technical designations given to different departments and school of divers institutions, in the practical classification of students, and in matters of educational administration are so divergent that any attempt to squeeze the statistics of sixteen institutions into a rigid form that may meet with the requirements of one or of several of the institutions considered, is manifestly absurd, or at least unwise. It would obviate some of the misinterpretations which a comparison of the statistics of the accompanying table may entail, if space permitted a succinct statement of the institutional variations above alluded to. However, bearing in mind these facts, we offer the figures which have been received in the approximate form in which they were sent. Uniformity in this matter must, therefore, be relative, not absolute. After all, in the absence of universally accepted stated definitions and requirements which for comparative statistical purposes it would be a happy circumstance to have all universities respect and obey, figures of this character function merely as probable hints, not as basic facts.

We would call attention to a few matters in connection with the table. In every instance an endeavor has been made to ascertain the increase or decrease in the various departments as compared with the registration of 1899. Such increase or decrease where obtainable is represented by the figures in parentheses. Unfortunately, returns are not at hand from several other representative institutions in which there is a common interest. However, the scope of country represented by the institutions herein enumerated is undoubtedly sufficient in extent to indicate the general status and progress of higher education in the United States. GEO. B. GERMANN.

Stanford.	Michigan.	Minnesota.	Missouri.§§	North-western.	Pennsylvania.	Princeton.	Wisconsin.‖‖	Yale.
	638(—3)	485 (64)	482 (30)	349 (70)	421 (21)	745 (59)	529	1192
1178 (70)	591(—6)	592 (72)		261(—13)			406	
	353 (84)	347 (61)	246 (13)		336 (30)	428 (61)	390	610
185 (24)	809 (88)	480(—48)	115 (9)	175 (5)	344 (32)		258	210
	591 (73)	512(—44)	82 (21)	404 (0)	566(—116)			133
			88(—204)				18	
		590 (87)						75
	278 (34)			560 (30)	415 (—69)			
								89
								7
							125	126
	69(—3)			164 (27)			42	
			59 (—12)					
					57 (11)			
84 (?)	80 (4)	177 (0)	35 (15)	35 (5)	150 (—2)	78(—63)	101	299
			15 (8)		20 (?)			
					230 (—32)			
56(—8)	404(141)	275(—27)	439 (171)				329	
					10 (—9)		60	
							73	205
1318 (62)	3813(219)	3423 (187)	1335 (129)	1948 (124)	2549(—124)	1251 (57)	1856(144)	2536(19)
	220 (13)	8	74 (6)	299	265		156 (20)	

§§ Statistics of November 12th. Registration not completed, particularly in agriculture, the courses of which open late in the term.

‖‖ Statistics of November 15th.

°° Exceptional increase due to first session of Summer Schools in 1900.

SCIENTIFIC BOOKS.

One Thousand American Fungi; How to select and cook the Edible; How to distinguish and avoid the Poisonous; giving full botanic descriptions made easy for reader and student. By CHARLES McILVAINE, assisted by ROBERT K. MACADAM, Indianapolis. Bowen-Merrill Co., with 65 plates, 34 colored, and numerous cuts. Large 8vo. Pp. 704.

The fashion of gathering and eating fungi, which has suddenly become almost a mania with many people in this country, has called forth a considerable number of books and tracts intended to aid those who have no previous knowledge of fungi to distinguish between the edible and poisonous species. As is seen from the title, the present work has for its object to make the subject easy for the reader and the student. The first thing which the student demands is good illustrations, which, in the case of most fungi classed as edible or poisonous, must be colored in order to be recognized at once. Unfortunately the colored plates of Dr. McIlvaine's book are not satisfactory. Too many species are often crowded together on a single plate, the drawing is too sketchy and the colors, which have a washed-out look are not true to nature. The plate of *Clitocybe illudens* is almost the only one of the colored plates which is at all satisfactory and, were it not for the names attached, in many cases expert mycologists would be at a loss to know what species are represented. On the other hand, the photographic reproductions are excellent and, where color is not an essential feature, serve their purpose admirably. Plate 158, a good picture of *Phallus Ravenelii*, is marked *Phallus impudicus*, although the veil characteristic of that species is wanting.

Turning to the text, we are told that the book is the result of ten years' labor and that the author has added over six hundred species to the one hundred and eleven edible species enumerated by the Rev. M. A. Curtis. From this long practical experience of Dr. McIlvaine he must have acquired a large fund of information valuable to the would-be mycophagist. It is to be regretted that the author's style is marked by an absence of simplicity and clearness, and that he is given to repetition and to frequent side remarks in which sentimentality rather than scientific accuracy predominates. A serious fault, due rather to the lack of clearness in writing than to any desire to misrepresent, is the mixing up of what the author has himself observed with what he has learned from the writings of other mycologists and, in too many cases, one who is not already familiar with the literature cannot tell where the quotations from other writers begin and end. One would like to know exactly what has been the result of Dr. McIlvaine's own experience, and that is not always easy to find out. What is said about *Boletinus porosus* illustrates this point. That species is a common and striking fungus in the eastern part of the country and when raw it has a most disagreeable taste which promises little to the mycophagist. One would like to know what has been Dr. McIlvaine's experience with this species. On turning to p. 403 we find only the following statement: "Fine specimens were sent to me by Mr. H. I. Miller of Terre Haute and Dr. J. R. Weist, Richmond, Ind. They were in condition to be eaten and enjoyed. No disagreeable odor was perceptible." Does this mean that Dr. McIlvaine ate the specimens and enjoyed them? His statement is certainly not explicit enough to satisfy those who have been nearly nauseated eating this fungus raw. Whether a fungus is edible or not often depends on circumstances and in any work intended to instruct students the conditions should be stated. To take *Gyromitra esculenta* as an example, Plate VI. is a somewhat sensational representation of a group of dangerous fungi. A small but very red devil is sitting under the shadow of a large skull reading a book called toxicology. In the foreground is a very bad picture of *Gyromitra esculenta* which, from its surroundings, the reader would infer to be deadly. But on p. 547, in speaking of this species, we find the following: 'Since 1882 myself and friends have repeatedly eaten it. In no instance was the slightest discomfort felt from it. It was always enjoyed.' Now the facts in the case of the *Gyromitra* are these: as long ago as 1882 Bostroem* showed that an active poison exists in this species, but it is soluble in boiling water and there-

* Ueber die Intoxication durch die essbare Lorchel. Eugen Bostroem, Leipzig. 1882.

fore, if the water in which the fungi have been boiled is carefully removed, they can be eaten with impunity. If by experiment Dr. McIlvaine has found Bostroem's observations to be incorrect, he should have made some statements to that effect. Otherwise he should have mentioned Bostroem's experiments in the paragraph in which he speaks of the fungus as edible. As it is, we are not even informed whether in his own cases the water in which the *Gyromitra* was cooked was removed or not. That part of the book treating of the poisonous Amanitæ, a subject of vital importance, is by no means clearly written. The facts are given, but they are so ill arranged that they must be obscure to the persons to whom the book is especially addressed.

With regard to that part of the work treating of the species not preeminently edible or poisonous, and they form the greater part of the whole, it may be said that as a summary of species compiled from many scattered sources, it serves a useful purpose, since in the present state of our knowledge anything like a complete or very accurate account of our larger fungi is out of the question. It would have been well to cite the publications where the different species were originally described, as well as the name of the original describer. In the effort to make the list of species described as complete as possible the mistake has been made of accepting without sufficient discrimination the names and descriptions of different authorities, the result being that the same species in several instances appears not only under different names but with different descriptions in a way puzzling to students who attempt to ascertain the specific distinctions.

The chapter by Professor W. L. Carter on 'Toadstool Poisoning and its Treatment' stands out in bright relief from the rest of the book in its clearness and scientific treatment of the subject. There is also a good practical chapter on cooking and preparing fungi for the table and a good glossary, and the press work is all that need be asked. The great merit of the book lies in the record of the large number of species eaten by the author without injury, in the excellent photographic reproductions, the useful although somewhat indiscriminate summary of our native species, and the chapters on toadstool poisoning and on cooking fungi. The faults of the book are due mainly to the fact that the style of the author is discursive and confused rather than clear and concise and the temptation to write a large book where a shorter and more accurately scientific treatise would have answered the purpose better has not produced the best result. Although valuable in many ways, it does not seem to us to be so well adapted to the general reader and the student to whom it purports to be addressed as the excellent book of Hamilton Gibson, 'Our Edible Toadstools and Mushrooms.'

A Treatise on Zoology. Edited by E. RAY LANKESTER. Part II. The Porifera and Cœlentera. London, Adam and Charles Black; New York, Macmillan & Co. 1900.

The second volume of the 'Treatise on Zoology,' edited by Professor Lankester, has quickly succeeded the first. It includes an introductory chapter by the editor, followed by a chapter on the 'Porifera,' by Professor E. A. Minchin, and chapters on the 'Hydromedusæ and Scyphomedusæ,' by Mr. G. H. Fowler, and on the 'Anthozoa and Ctenophora,' by Mr. G. C. Bourne. The amount of space occupied by the various chapters is, however, very unequal, Professor Minchin's admirable account of the sponges extending through one hundred and sixty-eight pages, while the Hydromedusæ and Scyphomedusæ together are discussed with only seventy-six, the Anthozoa receiving eighty and the Ctenophores twenty-three.

The introductory chapter by the editor is full of interest as a summing up of the results of the important investigations which he and his pupils have been conducting for many years on the significance of the various cavities known as cœlomic. Lankester recognizes primarily only one form of cœlom, the gonocœl, a space surrounding the reproductive cells, though secondarily it may enlarge and become divided to form cavities surrounding other organs, as in the Vertebrates, for example, in which it forms the pericardial, pleural and peritoneal cavities. In the Arthropods, on the other hand, it becomes very greatly reduced concomitantly with the formation of a hæmocœl, produced by the distension and fusion of spaces primarily belonging to the vascular system, a method of cœlom-formation to which Lankester applies the somewhat cacophonic term *phlebœdesis*. As a corollary of this view of the cœlom a division into two groups of the organs usually termed nephridia has resulted; those which terminate in a flame cell, such as those characteristic of the Platyhelminths, Rotifers, Chætopods and of certain larval Mollusca, have been placed in one group and retain the original name, while those which stand in relation with the gonocœl or its derivatives, such as those of the adult Molluscs, the Arthropods and Vertebrates, form the second group and are termed uroducts. In passing it may be remarked that we cannot help wondering why, in speaking of nephroblasts on p. 34, the credit for their discovery is assigned chiefly to Bergh, the actual discoverers, Whitman and Wilson, being probably included in the term 'other observers.' Is it possible that Professor Lankester finds his greatest joy in one sinner who repents?

The theory thus briefly outlined has certainly much in its favor, though it must be confessed that doubts are still permissible as to the fundamental distinction between the two forms of cœlom. Final judgment on this point must at all events be postponed until further information as to the developmental history of the cœlomic and vascular spaces of such forms as the Nemerteans and Hirudinea is at our disposal.

In connection with the theory Lankester introduces many new terms, a list of which with definitions forms the concluding section of the chapter. The majority of these are undoubtedly necessary, if the theory be correct, but the terms Enterocœla and Cœlomocœla, used in the heading of the chapter, and proposed as substitutes for the more familiar names Cœlentera and Cœlomata, are certainly open to objection. Perhaps they are more symmetrical than the older terms, but a name, after all, is but a peg whereon to hang an idea, and a superabundance of pegs for one idea is just as confusing as a lack of one, and, furthermore, the term Enterocœlia has already been employed by the Hertwigs for the suspension of a very different idea.

Professor Minchin's chapter on the Porifera is admirable in every respect and fully harmonizes with the excellent work he has previously published upon the group. His treatment of all the points of view is full and accurate, and his discussion of the affinities of the group and the phylogeny of its various subdivisions is clear and suggestive. He inclines to the view of an early separation of the sponges, as the Parazoa, from the remaining Metazoa and maintains the non-identity of the germ layers in the two groups. The chapter, in a word, may be taken as an accurate and comprehensive statement of our present knowledge of this interesting group.

Unfortunately, so much cannot be said without reservation regarding the remaining chapters of the volume. Mr. Fowler's chapters do not evidence the same familiarity with the forms described that is seen in Professor Minchin's work, and the same is true, to a certain extent at least, of Mr. Bourne's contribution. The chapters on the Hydromedusæ and Scyphomedusæ are sketchy, as may be appreciated from the fact that the latter group requires but sixteen pages, or really, if the space occupied by the fourteen figures be deducted, but little more than ten pages. The principal facts concerning the structure and histology of the two groups are given, it is true, but the brevity of style which the author affects leads occasionally to statements which convey erroneous impressions, as, for instance, where it is stated that the threads of the nematocysts 'are formed (*sic*) and lie inside the vesicles,' where delamination alone is given as the method by which the germ layers are formed in the Hydromedusæ, and where invagination is alone given as the corresponding process in Scyphomedusæ. And one misses also some treatment of the broader questions suggested by the structural peculiarities of the group. Thus one finds no discussion of the interesting question as to the origin of the alternation of generations in the Hydromedusæ, so admirably treated by Brooks, nor of the corresponding phenomenon in the Scyphomedusæ, and one searches in vain for any discussion of the phylogeny of the various orders into which the two classes are divided, or for any adequate treatment of the principles underlying the polymorphism so strikingly manifested by the Siphonophores.

In the chapters contributed by Mr. Bourne one finds side by side an admirable treatment of some groups and faulty accounts of others. Thus of the groups in which Mr. Bourne has accomplished admirable investigations, the Alcyonaria and corals, the description is very good, but for the most of the remaining groups the treatment is sadly behind the times. This is especially the case with the forms which he includes under the order Actiniidæ, because so much has been accomplished within recent years in connection with this group, and with these recent advances the author appears to be entirely unfamiliar, basing his classification, as he states, on the work of Hertwig (1882, 1888) and Andres (1383). It is to be remembered that Hertwig's work formed merely the starting point for a reconstruction of the taxonomy of the Actiniidæ, and the progress of the reconstruction has gone on since its publication with rapid strides.

Some excuse, however, may be found for many of Mr. Bourne's taxonomic enormities in the fact that the chapter was evidently written as many as four and possibly even five years ago and has since remained unpublished. But when we read on p. 38 that 'pains have been taken to make it (*i. e.*, the classification of the Zoantharia) as fully as possible representative of the actual state of our knowledge,' and find the volume in which this statement appears dated 1900, we are justified in expecting some record of the results of comparatively recent investigations. Apparently, however, there has been practically no attempt at a revision of the original manuscript, and though Mr. Bourne may not be responsible for the delay in its publication, he may well be held accountable for the failure to bring it up to date.

A detailed criticism of the classification adopted for the Actiniidæ would almost result in a comprehensive review of the entire order, but a few errors may be mentioned in justification of the criticism made above. One finds, for instance, no mention of the family Aliciidæ established by Duerden in 1895, its type, Alicia (Cladactis), being referred to the Bunodidæ; Hertwig's family Liponemidæ is retained and no mention is made of the family Boloceridæ (McMurrich, 1893); the Phyllactidæ are described as belonging to a group possessing foliaceous tentacles, though their foliaceous organs are really highly modified marginal spherules, as was shown by McMurrich in 1893; and Savaglia is suggested as a member of Hertwig's family, Amphianthidæ, although Carlgren showed in 1895 that it is really a Zoanthid. These for samples: a long catalogue of sins both of omission and commission might readily be made, and, naturally, the unfamiliarity with recent work has led to errors of statement in the descriptive part of the work.

With the corals, as stated above, the case is different, though even here the soft parts, so important for the proper understanding of the affinities of the group, are barely mentioned, being dismissed with only six lines of description. And little fault is to be found with the chapter on the Ctenophores, in which an accurate and sufficiently complete description is found, the author deserving especial credit for the stand he has taken against the current but erroneous idea that these forms are Cœlentera or even directly derived from any of the existing Cœlenterate groups.

Attention has been directed in what has been said above, chiefly to the failings of the volume and possibly an erroneous impression as to its general excellence may have been given. It is, nevertheless, a valuable book to place in the hands of the 'serious student' for whom, the preface informs us, it was written, and even though it fails here and there to be an entirely 'trustworthy presentation * * * of the main facts of zoology' it is assuredly worthy of a place on the reference shelf of every zoological laboratory. It may be stated that the illustrations are abundant and, as a rule, excellent, and bibliographic lists and good indices are given at the end of each chapter.

J. P. McM.

Contributions a l'étude des hyménoptères entomophages. Par L. G. SEURAT. Ann. des Sciences Naturelles. Zoologie, X., Nos. 1–3, Paris, 1899. Pp. 1–159. Pl. I–V.

The development of the larvæ of those parasitic Hymenoptera which live within the bodies of other insects has been the subject of much speculation and of some investigation. How these creatures breathe, nourish themselves, move, molt and pass their excretions, have been mooted points. Cuvier thought that these larvæ breathed by placing their spiracles in relation with those of the host insect. Gerstaecker, in 1863, came to the same conclusion. Ratzeburg attributed a respiratory function to the anal vesicle in certain Braconids and to the caudal appendage in the Ichneumonids. Boisduval concluded that they do not take nourishment through the mouth, that they do not breathe and that they void no excrement, the larva being analogous to the fœtus in mammalia, which lives the life of the mother. Newport described the larvæ of certain Ichneumonids as having no anus, the rectum and its orifice being rapidly developed at the final larval change. The older authors thought that these larvæ attack only the fatty tissues of the host. Bugnion states that Encyrtus nourishes itself exclusively on the lymph. Ganin has observed a curious hyper-metamorphosis in certain egg parasites of the family Proctotrypidæ. Marchal has made some extraordinary observations upon other Proctotrypids, showing that one form (Trichacis) develops in the nervous system of Cecidomyia, while Polygnotus develops in the digestive tract of the same host.

Seurat, in the paper under consideration, reports the results of investigations which he has conducted upon members of three families of parasitic Hymenoptera. He has studied the Braconids, *Apanteles glomeratus* in the common European cabbage worm, *Aphidius fabarum* in the common *Aphis rumicis* and *Doryctes gallicus*, an external feeder on a wood-boring larva. The Ichneumonids studied are two internal feeders, *Mesochorus vittator* and *Hemiteles fulvipes*, and one external feeder, *Xylonomus præcatorius*. Among the Chalcidids he has studied *Diplolepis microgastri*, an internal-feeding hyperparasite in Microgasterid cocoons, and an external feeder, *Torymus propinquus*, which lives in Cecidomyiid galls, feeding externally on the Cecidomyiid larvæ. The work has been done with the greatest care and the conclusions at which he arrives are of authoritative value. They are summarized as follows:

(*a*) *Manner in which larvæ nourish themselves.*—The external and internal larvæ are formed with very sharp mandibles. The internal forms use them in order to pierce the tissue of the host; the external ones to pierce the skin of the host, making a delicate orifice which permits them to suck up the tissues. The digestive tube is always remarkable by the presence of the very voluminous stomach closed behind (this proves to be the rule in the young larvæ of Hymenoptera) and which serves as a sort of storehouse for food which is digested later. A small quantity of food digested at once suffices for the immediate wants of the larva. The voiding of the excrement only takes place in the interior of the cocoon, the stomach not opening until that time. The stomach of the larva contracts and dilates very rapidly, these movements probably favoring the ingestion of food. The materials which the parasite borrows from its host are varied. In certain cases (*Apanteles glomeratus*) the fat, the blood and the lymph only disappear. In the majority of cases the parasitic larva devours everything except the skin and tracheæ. The parasite respects the viscera up to the last limit and only sacrifices them at the end. He has seen in certain cases the larva devour several host insects.

(*b*) *Respiration.*—The problem of the mode of respiration is a puzzling one with internal feeding larvæ. External larvæ are provided with spiracles permitting the entrance of air. The respiration of the young internal larvæ not yet provided with tracheæ filled with air is effected by osmosis through the skin by the whole surface of the body. The larvæ furnished with an anal vesicle or caudal respiratory appendage breathe with the skin of these organs as well as with the whole surface of the body. These appendages are lacking, however, in certain cases, as in the Aphidiinæ, the Chalcididæ, etc. The tracheæ are not slow in appearing elsewhere. The tracheal system is complicated in accordance with the needs of the larva. *It is entirely closed* and the entrance of the air is made through the skin and the very fine membrane of the ultimate tracheal branches. The entire surface of the skin is carpeted with an extremely rich net-work of fine tracheæ which facilitate the accomplishment of this function. The hypothesis of the osmosis of air from the liquid tissues of the host through the body wall of the parasite and the cover of the tracheæ is not extraordinary. Weismann, having placed the larva of *Musca vomitoria* under water, has seen that the tracheal system remains filled with air at the expiration of several hours. The respiration of internal larvæ is then very normal, the tracheal system having undergone slight modifications. Upon leaving the host the spiracles open and the air enters through them.

(*c*) *Molts.*—He has observed a molt in the young internal larva of *Apanteles glomeratus.* The mandibles and the larval cuticle are shed. In certain of the young larvæ, one sees, in fact, after the molt of the body, the two mandibles of an earlier stage. The molt is made like that of the pupa, the old skin slipping from before towards the anal end of the body. The larva sheds this old skin into the open space behind it.

Such are the facts concerning the mode of life of internal parasites in their hosts. There is really nothing mysterious in this mode of life. The functions are accomplished normally by means of slight modifications which it would have been easy to foresee.

M. Seurat is heartily to be congratulated on this excellent piece of work, setting at rest, as it does, so many mooted points. It is interesting to note that he has not made any observations at all parallel to those of Marchal, who states that a single egg of Encyrtus laid in the egg of Hyponomeuta dissociates itself into a great number of embryos which develop into individual larvæ in the larva of the host.

L. O. Howard.

The Structure and Life-History of the Harlequin Fly (*Chironomus*). By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. Oxford, Clarendon Press. 1900. Pp. 191; figs. 129.

Professor Miall has gained an enviable reputation as a student of the life history and structure of a number of common insects, and in the course of this work he has discovered many novel and important facts. His little book entitled 'The Structure and Life-History of the Cockroach,' done in collaboration with Alfred Denny, is a model treatise on Orthopteran insect anatomy and his treatise on 'The Natural History of Aquatic Insects' is one of the most valuable and readable entomological books which has been published of late years. In the present volume the authors have given a very careful study of the development of the Chironomidæ, some of the species of which have long been favorite objects with histologists and embryologists. They have a very special biological interest in their various stages and it is thought that their inclusion in ordinary teaching courses will be desirable and will be facilitated by the present volume. *Chironomus* larvæ are very abundant and are found in pools and streams and at the bottom of deep fresh water lakes, Professor S. I. Smith having dredged them from the bottom of Lake Superior at a depth of nearly 1,000 feet. They have also been found in salt water and Packard has studied a species abundant at low water mark in Salem Harbor.

The larvæ inhabit tubes which they make of silk and mud or aquatic vegetation, and certain of the larvæ possess only a rudimentary tracheal system which appears late in the larval stage. No insect known to the writers has more completely departed from the habits and structure of an air-breathing animal, yet even here is found proof of descent from a terrestrial insect with branching air tubes. This remarkable modification is necessary from the fact that certain of the larvæ live at great depths where it is impossible for them to rise to the surface. This absence of a tracheal system does away with the possibility of breathing by tracheal gills which is the commonest respiratory method with aquatic insects and necessitates the presence of blood gills, so that respiration is accomplished practically as with fishes and larval *Batrachea.*

The whole internal anatomy of all stages is carefully described, with excellent figures, and this is done in a masterly and comparative way and includes a study of the embryonic development. An appendix is devoted to the methods of anatomical and histological investigation.

An important point which the authors bear in mind and which Professor Miall has frequently advanced is that they desire by such work to incite the members of naturalist clubs and other non-academic biologists to take up the study of life histories. Such work in the past has yielded facts of the greatest biologic importance, and yet to-day the field is largely neglected. The great nature-study movement which is making such rapid strides in this country would be encouraged and assisted by many more such books as this if we had the investigators and writers able to make such careful studies and to put them in print in such admirable shape.

L. O. Howard.

Transactions of the American Society of Mechanical Engineers. Vol. XXI., New York Meeting, 1899, Cincinnati Meeting, 1900. New York; published by the Society, 1900. Pp. 1778; 8vo., 372 ill.; 33 papers, reports of committees, etc. Printed by J. J. Little & Co.

This large and handsome volume represents the work of the American Society of Mechanical Engineers, so far as it can be exhibited in type, for a single official year. The organization was effected in 1880, after many unsuccessful attempts had been made by other less influential or less tactful members of the profession, and started off with a small number of members selected from among the leaders of the profession of engineering. It now has a total membership of 2,064, including 113 foreign members. The officers are a president, six vice-presidents, nine managers, a treasurer and a secretary, while its governing body, the Council, includes the officers, and the past-presidents of the Society are 'honorary councillors' holding their positions for life or during their continued connection with the Society. Two conventions are held each year, one in New York, at headquarters, the other at usually, some large city in the central or western portion of the country. All persons engaged in engineering are eligible to membership, under certain restrictions and in classes, as members, honorary members, juniors, associates; the Council making a first revision of the list and recommending to the Society those whose credentials are considered satisfactory. The headquarters of the Society are at its own house, No 12 West 31st St., New York City, formerly that of the Academy of Medicine.

The published papers and their discussions cover a very wide range of topics and are supplemented by a series of 'topical discussions' in answer to queries suggested by members and sent out by the Council. These volumes are rich in valuable fact and data thus derived.

The papers are often of considerable length and their value is often proportional to their volume. Thus the report of the Committee of a Standard Method of Steam-boiler Trials, 78 pages, is followed by a discussion occupying 27 pages; Admiral Melville gives 17 pages to 'Engineering in the U. S. Navy'; Thurston on 'The Steam-Engine at the Close of the XIXth Century,' occupies 61 pages; Dr. Eddy on 'Entropy,' submits 17 pages; Laird on a 'Remarkable Steam Pumping Engine Trial,' 24 pages; Goss on a similar work, 39 pages; Robertson on the 'Test of a 125 horse-power Gas-Engine,' covers 43 pages; Herschman on 'The Heavy Automobile,' 30 pages; Kerr's admirable paper on the 'South Terminal Station, Boston,' occupies 27 pages; Professors Cooley and Wagner on a 'Nordbury Engine,' admirably full, 96 pages, while the most generally interesting paper of the volume, apparently, that of Professor Higgins on 'The Education of Machinists, Foremen and Engineers,' 19 pages, is discussed in 86 pages and is supplemented at the second meeting of the volume by another paper, occupying 40 pages, in which the author closes a most extraordinarily interesting and instructive discussion, perhaps the most important and instructive respecting technical education ever yet put in type.

A very large proportion of the papers are devoted to accounts of investigations of the performance of heat-engines and of machinery of interesting, and commonly of novel, character and to descriptions of the processes of experimental research and resultant data. The file of the twenty years past is extraordinarily rich in this, to the engineer, most superlatively valuable material. A large part naturally comes from the technical schools and colleges; but it is always practically valuable and often, if not invariably, conveys a form of knowledge that the practitioner most desires. The fact, however, that the 'practical man' cannot be induced to present oftener, and in good form, the outcome of his experience and the results of his endeavors to secure improved design, to invent new devices and processes, and to secure more perfect constructions and more permanently valuable operation of his machinery, is lamented in some of the discussions and with good reason ; yet it is obvious that this lack is entirely natural ; but it is equally obvious that when the technically educated and professionally trained men of the coming generation, now just issuing from the technical and professional schools, to take the lead in the work of the industries of all departments, shall have reached their period of maturity and of maximum usefulness, this difficulty is likely largely to disappear. In fact, the technical papers of the time are coming to more and more illustrate the literary, as well as professional powers of this class.

The illustrations are all well-made, some half-tone, others engraved, many diagrammatic, and constitute a most important feature of the volume. The book-making is excellent and the whole may be taken as among the best, if not itself the very best, of illustrations of the character of the work of the contemporary man of science in these departments of application. The mechanic and engineer of to-day is the maker of the modern material world and it gives the average citizen of every civilized country a feeling of satisfaction and of safety to find that he is at once 'practical' and scientific, experienced and learned, competent to unite the best of scientific knowledge with the richest of technical experience in the design, the construction and the operation of the machinery of the world and in thus building the foundations of our civilization broad and deep and solid. This volume has large significance from the point of view of the economist, the educator, the philosopher and the statesman, as well as from that of the technicist and the engineer.

Its editor, the secretary, deserves cordial congratulations.

R. H. THURSTON.

BOOKS RECEIVED.

Elementary Anatomy, Physiology and Hygiene. WINFIELD S. HALL. New York, Cincinnati and Chicago, American Book Company. 1900. Pp. 273. 75 cents.

Life and Letters of Thomas Henry Huxley. LEONARD HUXLEY. New York, D. Appleton & Company. 1900. Vol. I. Pp. xi + 539. Vol. II. Pp. vii + 541.

The Limitation of Learning and other Science Papers. ALBERT SCHNEIDER. Chicago, Chicago Medical Book Company. 1900. Pp. 100.

Text-book of the Embryology of Invertebrates. E. KORSCHELT and K. HEIDER. New York, The Macmillan Company. London, Swan Sonnenschein and Company. 1900. Vol. IV. Pp. xi + 594. 18s.

One Thousand Problems in Physics. WILLIAM H. SNYDER and IRVING O. PALMER. Boston, Ginn & Company. 1900. Pp. v + 142.

An Elementary Treatise on Qualitative Chemical Analysis. J. F. SELLERS. BOSTON, Ginn & Company. 1900. Pp. ix + 160.

The Progress of Invention in the Nineteenth Century. EDWARD W. BRYN. New York, Munn & Company. 1900. Pp. viii + 476. $3.00.

Die Erdströme im deutschen Reichstelegraphengebiet und ihr Zusammenhang mit den Erdmagnetischen Erscheinungen. B. WEINSTEIN. Braunschweig, Friedrich Vieweg und Sohn. 1900. Pp. vi + 78 and 19 plates.

Theoretische Betrachungen über die Ergebnisse der wissenschaftlichen Luftfahrten. WILHELM VON BEZOLD. Brunschweig, Friedrich Viewig und Sohn. 1900. Pp. 31.

Über Museen des Ostens der Vereinigten Staaten von Nord Amerika. A. B. MEYER. Berlin, R. Friedländer und Sohn. 1900. Pp. viii + 72.

The Biography of a Baby. MILLICENT WASHBURN SHINN. Boston and New York, Houghton, Mifflin & Co. 1900. Pp. 246. $1.50.

A Reader in Physical Geography. RICHARD ELWOOD DODGE. New York, London and Bombay. Longmans, Green & Company. 1900. Pp. ix + 231.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 329th meeting was held on Saturday evening, December 1st.

L. Stejneger presented a paper 'On Post-Pliocene Migrations of Siberian Animals into Europe,' saying that three invasions of Siberian higher vertebrates into western Europe are distinguishable since Pleistocene times. The first one took place before the maximum glaciation of the ice age, at a time when Ireland and Norway were both connected with Great Britain, and the latter with France. The second invasion, the so-called 'Great Siberian Migration,' took place after the deposition of the continental boulder day in Central Europe, and the retreat of the glaciers, reaching only England, as Ireland and Norway had become detached by that time. A branch of this invasion reached Scandinavia from the east. The third invasion is still in progress, being most marked and most easily demonstrated along the shores of the Arctic Ocean, entering Scandinavia from the northeast over Finland and northern Russia, a comparatively recent connection between Norway and Siberia. The immigration of a number of birds and mammals into Scandinavia by this route was treated in detail, from both a historical and a distributional point of view.

Erwin F. Smith spoke of 'Sugar Beets in New York and Michigan,' describing the methods of beet cultivation and the various steps in the process of making beet sugar. As many as three hundred acres of beets were raised on one farm, and the daily output of one of the smaller factories was five tons. In theory, the speaker stated, the beet crop was one of the best possible for the land, since by utilizing the waste products of the sugar factory, the potash taken from the soil could be returned to it, but unfortunately in practice this was not done and the waste products, instead of being used, were in Michigan dumped into the streams. Beet diseases, it was said, were already a serious problem, causing serious losses to the farmer, and other diseases would doubtless be introduced from Germany, whence came most of the seed used in this country.

F. A. Lucas.

THE ROYAL SOCIETY.

The report of the Council states according tot he London *Times* that during the past year its time and attention had been largely occupied by business connected with matters of national and international scientific interest, in which her Majesty's Government had either directly sought the advice and assistance of the Society, or had itself given assistance and financial support to undertakings promoted by the Society in the interests of science. The operations of the National Physical Laboratory had been carried on in the buildings of the Kew Observatory. The control of the work carried on by the Kew Committee of the Royal Society was taken over by the executive committee from January 1st, and the property of that committee was made over to the Royal Society from that date. The committee, which was incorporated as a public company, has since been dissolved. The work at Kew Observatory had been continued in all its branches. After considerable discussion, plans for a physics building, at an estimated cost of £6,000, and an engineering laboratory, at an estimated cost of £4,000, were approved by the executive committee and submitted to the general board. Unfortunately, all these plans must be discarded, and very grave loss of time had been caused by the unexpected opposition to the erection of the laboratory in the Old Deer-park. Her Majesty's Treasury had now informed the Council that her Majesty was willing to assign the lease of Bushey-house and the surrounding ground, thirty acres in extent, for the purpose of the National Physical Laboratory, and that the Government would increase the grant for building by £2,000 in order that the extensive alterations and repairs which would be necessary might be carried out. Though the Council regretted the decision of the Government not to erect the laboratory in the Deer-park, they recognized with gratitude that her Majesty had been graciously pleased to place at the disposal of the Society a site in which the work of the laboratory could be carried on, and they had, therefore, accepted the offer made to them by her Majesty's Treasury. The committee had to thank various donors for gifts. Sir Andrew Noble had contributed £1,000 for the purchase of apparatus. Dr. Isaac Roberts had given a spectroscope and two very valuable induction coils. Dr. Common had provided apparatus for determining the magnifying power and testing

* 'The Principles of Stratigraphic Geology,' by J. E. Marr, 1898, p. 98.

† See *Bull. Amer. Paleont.*, No. 13, November, 1900. Ithaca. 26 pp., 5 pl. Describes twenty new species of calciferous Gastropoda, Brachiopoda and Trilobites; also one new genus of Trilobita, all from the Mohawk Valley, usually considered unfossiliferous.

the collimation error of the telescopic sights, and had promised a large flat surface for optical work. Mrs. Sworn had given two thermometers (used by her late husband). The report dealt also with the disturbance of magnetic observatories by electric railways, the steel rails committee, and the national Antarctic Expedition. With respect to the latter it was stated that the commander of the expedition, Commander R. F. Scott, R.N., the head of the scientific staff, Professor Gregory, and three other officers had been appointed, and it was confidently hoped that the expedition would be ready to start by August, 1901, when the German Antarctic Expedition was also expected to sail. Funds had been raised exceeding £91,000, including the grant from her Majesty's treasury of £45,000. This fund was raised in view of an expedition lasting two years, but appeals were being made for more funds to enable the expedition to remain in the Antarctic for three years, for which the sum of £120,000 was required. The report also dealt with malaria, into which the results of the investigations had now been published in part. Other subjects were the 'Solar Eclipse of May 28, 1900,' and the 'International Catalogue of Scientific Literature,' on which considerable progress had been made. Her Majesty's Government had guaranteed £1,000 a year for five years, 'to make good to the Royal Society a part of any loss which might be incurred by the publication of the proposed catalogue.' At the International Association of Academies, the first meetings of which were held at Paris on July 31 and August 1, 1900, the Royal Society was represented by Professor Rücker. As matters at present stood, the Royal Society being regarded as a scientific society only, the United Kingdom could only be represented on the scientific section of the Association. With respect to the Mackinnon Bequest it had been decided that the award should be in the nature of a studentship for the encouragement of research rather than a prize for the reward of past achievement, and tha the studentship (which at present amounted to about £150 per annum) should be devoted to the maintenance of a student engaged in research. Under the will of the late Professor Hughes, a bequest of £4,000 had been made to the Royal Society with a direction to award the income annually as a prize either in money or in the form of a medal, or partly one and partly the other, for the reward of original discovery in the physical sciences, particularly electricity and magnetism, or their applications, the prize or medal to be given under conditions to be fixed from time to time by the Society on lines similar to those followed in the bestowal of the Copley, Rumford and Royal medals. The report also dealt with terms of bequest, the apartments of the Society, electric lighting, the library, publications, the publication fund, the catalogue of scientific papers, the Government grant, general business and the presidency.

THE HARTMAN ANTHROPOLOGICAL AND ARCHEOLOGICAL COLLECTION.

THERE has just been exhibited at Stockholm a fine collection of archeologic and ethnographic objects from Central America, made by Dr. C. V. Hartman (formerly naturalist of the Lumholtz Expedition to North Mexico) at the instigation and expense of Engineer Åke Sjögren. In a short guide to the exhibition by Dr. Hj. Stolpe, we are told that Dr. Hartman began his researches in 1896 at Mercedes, where he discovered a large workplace for the manufacture of stone gods and other antiquities of unusual interest. Among those now exhibited are two standing figures of stone, the largest as yet brought to Europe from Central America, which were erected at the east end of a large oval tumulus, about 300 feet in circumference and covered with stone to a height of 22 feet. East of this was a rectangular court, walled with stone on three sides, with a cairn of about 90 feet in circumference and 12 feet in height in each of its eastern angles; and on the flat tops of these lay fragments of smaller statues. Afterwards Dr. Hartman went up to the high plateaux of the interior and investigated many cemeteries, especially those of Orosi, Chiricot (3,000 feet above sea level), Lemones and Santiago. The graves were examined in the most exact and scientific manner, such as had never before been attempted in these parts, and a foundation was thus laid for a chronological grouping of

Central American antiquities. In all, over 400 graves were opened, and showed a typical stone-age culture; no weapon or cutting tool of bronze, still less of iron, was found. But though the majority of the graves were uninfluenced by European culture, proof was not wanting that in two cases cemeteries at Orosi and Mercedes were in use after the Europeans had reached the New World. In a grave at Orosi were found some mosaic glass beads, clearly of Venetian origin, and in a grave at Mercedes was a large bead of blue glass. Another valuable contribution to the chronology of the find is afforded by a clay bowl found at Salvador, and bearing Maya hieroglyphs, which probably denote the number of a year according to their chronology, which unfortunately has not yet been connected with that of the Old World.

Similar explorations were carried out in the Guanacaste peninsula on the Pacific coast, and on the islands in the bay of Nicoya, also at Carrizal on the neighboring mainland. Dr. Hartman then proceeded to Salvador, where for nearly a year he dwelt in one of the largest villages inhabited by the Pipilas, an Aztec tribe, and devoted himself to the study of their manners and customs, and religious ideas and language. Here he made a rich ethnographic collection, also a collection of Indian antiquities from the neighborhood, and compiled the first vocabulary of a Central American Aztec dialect that has any pretence to completeness. He also made an anthropometric examination of 100 Aztec individuals, and took a number of photographs.

In Guatemala Dr. Hartman visited the Indian tribes, Cakchiquels, Zutujils, Quichés and Xincas, as well as the Huavas on Cape Tehuantepec in southern Mexico. His notes on the language of the last two are of the greatest interest, inasmuch as there was previously no material for the classification of their tongue. Here also may be mentioned a test of the so-called nahuatlisms, remains of the ancient Aztec language which have been adopted in the Spanish now spoken in those regions.

Dr. Hartman returned to Sweden in October, 1899, bringing the valuable collectious now exhibited, which Mr. Sjögren, with great generosity, has handed over to the Ethnographic Museum of the State.

THE GROWTH OF CITIES.

A RECENT census bulletin contains reports on the population of cities having 25,000 inhabitants, or more, in 1900. There were 159 of these cities which are placed in four groups according to their size. The increase in population from 1880 to 1900 is shown in the following table:

CLASSIFIED SIZES.	No.	POPULATION.			INCREASE FROM 1890 TO 1900.		INCREASE FROM 1880 TO 1890.	
		1900	1890	1880	Number.	Per cent.	Number.	Per cent.
Totals	159	19,694,625	14,855,489	9,933,927	4,839,136	32.5	4,921,562	49.5
Cities of 200,000 and over	19	11,795,809	8,879 105	6,311,653	2,916,704	32.8	2,567,452	40.6
Cities of 100,000 and under 200,000	19	2,412,538	1,808 656	1,009,163	603,882	33.3	799,493	79.2
Cities of 50,000 and under 100,000	40	2,709,338	2,067,169	1,368,309	642,169	31.0	698,860	51.0
Cities of 25,000 and under 50,000	81	2,776.940	2,100,559	1,244,802	676,381	32.2	855,757	68.7

The 19 largest cities are further classified as follows:

CLASSIFIED SIZES.	No.	POPULATION.			INCREASE FROM 1890 TO 1900.		INCREASE FROM 1880 TO 1890.	
		1900	1890	1880	Number.	Per cent.	Number.	Per cent.
Totals	19	11,795,809	8,879,105	6,311,653	2,916,704	32.8	2,567,452	40 6
Cities of 3,000,000 and over	1	3.437,202	2,492,591	1,901.345	944,611	37.8	591.246	31.0
Cities of 1,000,000 and under 2,000,000	2	2,992,272	2,146,814	1,350,355	845,458	39.3	796,459	58.9
Cities of 500,000 and under 1,000,000	3	1.645,087	1.334,686	1,045,670	310,401	23.2	289.016	27.6
Cities of 300,000 and under 400,000	5	1.724,455	1,351,539	960,767	372,916	27.5	390,772	40.6
Cities of 200,000 and under 300,000	8	1,996,793	1,553,475	1,053.516	443,318	28.5	499,959	47.4

The cities of over 1,000,000 should, however, be separated, Chicago having had an increase of 54.4 per cent. and Philadelphia of only 23.5.

*HARBEN LECTURES ON THE PLAGUE.**

THE first of the three Harben Lectures for 1900 was delivered at the Examination Hall of the Royal Colleges of Physicians and Surgeons, London, on November 7th, by Dr. A. Calmette, Director of the Pasteur Institute of Lille. After a short reference to the history of plague, he said it was possible for him to bring forward some modern views of the disease from his recent researches made as the result of his mission to Oporto last year with Salembeni. After giving a description of the plague bacillus, Dr. Calmette said plague assumed two principal clinical forms, bubonic plague, and plague without buboes. After describing the symptoms of plague he showed that the localization of the lesions in the gland determined the special attitude of the patient. The forms of the plague without bubo occurred more rarely than the classical forms of bubonic plague. Primary pneumonic plague was evidently due to the penetration of the microbe into the respiratory channels. It could be diagnosed only by bacteriological examination of the sputa, because the aspect of the sputum, the clinical symptoms, and the auscultatory signs resembled those of ordinary pneumonia. Another and still rarer form of plague without buboes was septicæmic plague or pesticæmia, which developed with extreme rapidity like acute septicæmia. It was caused by the rapid growth of the plague bacillus in the blood and in all the organs. It was not exactly known where the virus first effected an entrance in these cases, but the hypothesis was that it penetrated by the gastro-intestinal tract. When plague was studied in an epidemic center all the forms described were met with, but sometimes it happened that the first cases did not present such clear characteristics, and it was thus possible that they might be incorrectly diagnosed. At the commencement of a case of bubonic plague, that is to say, at the period when there was only glandular congestion and fever, to ascertain whether the plague microbe was present or not, a puncture should he made with a Pravaz's syringe into the lymphatic tissues, and some drops of fluid extracted. This could be inoculated in the usual manner and examined immediately after staining. To put the patient beyond the danger of any possible re-infection, it was only necessary, directly after the puncture with the syringe, to inject about 5 c.cm. of antiplague serum into the middle of the gland or at a short distance from it. If on examination of the fluid the microbes were found free and very numerous, the prognosis was serious; if the microbes were nearly all enclosed in polynuclear cells, it might be hoped that the case was non-malignant and that the infection would remain localized. It was essential, in testing the virulence of a plague microbe by experiments on animals, to use a recent culture, not older than twenty-four to forty eight hours at the most.

Mice, rats and guinea-pigs were very susceptible to plague, but it was thought that many other animals could take the plague. In this respect the pig, the ox and poultry had been mentioned, but these animals did not take the disease spontaneously. Birds were not easily infected by plague bacillus; the vultures on the Towers of Silense near Bombay suffered no ill after devouring plague corpses, but it was not proved that they did not scatter the plague microbe with their excreta on the surface of the soil. The monkey easily contracted plague by inoculation, and also spontaneously when placed in a cage side by side with another infected monkey. The bacilli could also be transported by fleas, by the other parasites of the skin and by flies. Healthy mice placed in the same cage with infected mice, but separated by wire, so that they could not touch each other, contracted the plague at the end of a few days; the contamlnation in these cases was due to fleas and flies. Professor Calmette illustrated his lecture with lantern slides, depicting patients affected with plague.

* From the *British Medical Journal.*

SCIENTIFIC NOTES AND NEWS.

PROFESSOR W. W. CAMPBELL has been appointed director of the Lick Observatory in succession to the late Professor James E. Keeler.

ON account of failing health Dr. Edward von Mojsisovics is retiring from the post of vice-director of the Geological Survey of Austria, into which body he entered as a volunteer on February 18, 1865, the director then being W.

von Haidinger. Dr. von Mojsisovics now hopes to bring to a more speedy conclusion his great works on the Cephalopoda of the Hallstätt limestone and on the geology of the Salzkammergut. All future communications should be addressed to him: Wien, III/3. Strohgasse Nr. 26.

The American Society of Naturalists and eight affiliated societies, devoted to the natural sciences, will, as we have already announced, meet at the Johns Hopkins University, beginning on Thursday, Dec. 27th. The proceedings of the Society of Naturalists are as follows: An address of welcome will be made by President Gilman on Thursday evening, followed by a lecture by Dr. Frank Russell, of Harvard University, on 'Indians of the Southwest,' and a reception in McCoy Hall. The annual discussion, which takes place on Friday afternoon, is on 'The Attitude of the State toward Scientific Investigation,' and the speakers are Professor H. F. Osborn, Columbia University; Professor W. B. Clark, Johns Hopkins University; Dr. L. O. Howard, chief of Division of Entomology, Washington, D. C.; Mr. B. T. Galloway, director of Plant Industry, U. S. Department of Agriculture and Professor W. T. Sedgwick, Massachusetts Institute of Technology. The address of the president, Professor E. B. Wilson, of Columbia University, will be given at the annual banquet on Friday evening. The headquarters of the Society are at Hotel Rennert.

The fourth annual meeting of the Society for Plant Morphology and Physiology will be held, with the American Society of Naturalists and the Affiliated Scientific Societies, at Johns Hopkins University, Baltimore, Md., on Thursday and Friday, December 27th and 28th, 1900. The usual social meeting will be held on Wednesday evening, December 26th. Among the special features of the meeting will be the presentation and discussion of an important report of the committee appointed to consider methods of securing improvements in reviews of current botanical literature, and two special lectures upon subjects of contemporary interest, one by Dr. Erwin F. Smith on 'Bacterial Diseases of Plants,' and one by Professor G. F. Atkinson, on 'Cytological Problems connected with Fertilization.' The address of the President, Professor D. P. Penhallow, will discuss 'A Decade of North American Paleobotany.' An excursion of the Society to Washington, to visit the United States Department of Agriculture, is planned for Saturday morning, December 29th. Further information about the meeting, and copies of the provisional program may be obtained from the Secretary, Professor W. F. Ganong, Northampton, Mass.

The Society of American Bacteriologists, organized at New Haven, in 1899, will hold its second annual session at Baltimore, in connection with the American Society of Naturalists, December 27th and 28th. The meetings will be held in the Pathological Laboratory of the Johns Hopkins Hospital. All interested in bacteriology, whether members of the Society or not, are cordially invited to attend the meetings. A program has been prepared which will occupy three sessions. A 'smoker' will be held on Wednesday evening at ten o'clock, at which time will be given the presidential address by Professor W. T. Sedgwick.

The other societies meeting with the Naturalists, to the arrangements of some of which we have already called attention, are: The American Morphological Society, The Association of American Anatomists, The American Physiological Society, The American Psychological Association, The American Folk-Lore Society, the Section of Anthropology of the American Association for the Advancement of Science.

The thirteenth winter meeting of the Geological Society of America will be held at Albany, N. Y., beginning on Thursday, December 27th, in the Chapel of the Albany Academy. The Council will meet at 9 o'clock on Thursday morning; the Society will be called to order by President Dawson at 10 o'clock. The president's address will probably be given on Thursday morning, and the subscription dinner will take place in the evening.

The twenty-second general meeting of the American Chemical Society will be held in Chicago, Ill., December 27th and 28th, 1900. Elaborate preparations have been made for it, and the meeting is sure to be successful. Plans are being made for celebrating on April 6, 1901, the 25th anniversary of the foundation of the Society.

PROFESSOR E. DANA DURAND, of Leland Stanford University, has been appointed secretary of the U. S. Industrial Commission.

MR. MERRITT LYNDON FERNALD, assistant in the Gray Herbarium of Harvard University, has recently been elected a fellow of the American Academy of Arts and Sciences.

DR. WESLEY MILLS, professor of physiology at McGill University, spent last year in Europe and was the guest of Professors His, Held and Flechsig, more especially while conducting researches on the nervous system. He returned in the latter part of September, and is devoting himself largely to the problem of the equipment of the new laboratory and the rearrangement of the courses in his subject.

IT is rumored that Mr. J. H. H. Teall will shortly succeed Sir Archibald Geikie as director of the Geological Survey of Great Britain and Ireland, and that Mr. C. Lapworth will be appointed to the chair of geology in University College, London, vacant by the resignation of Professor T. G. Bonney.

Nature reports that the government of Jamaica is obliged to retrench in the work of the Museum, necessitating the discharge of the curator, Dr. J. E. Duerden. Dr. Duerden has carried on important investigations in marine zoology, and the cessation of his work will cause regret amongst all zoologists.

A GENERAL committee is being formed to arrange a memorial of the late Professor Henry Sidgwick of Cambridge University. It may be remembered that Professor Sidgwick several years ago requested that his salary as Knightbridge professor of moral philosophy be reduced from £700 to £500 per annum, the reduction to continue until 1902. Mrs. Sidgwick has, in accordance with Professor Sidgwick's wish, contributed this year £200 and will do the same next year to carry out Professor Sidgwick's subscription for the benefit of the University.

WE regret to record the death of Professor Marshall Henshaw, formerly professor of physics and astronomy at Rutgers College and later lecturer on physics at Amherst College, and of Dr. S. Hoepfner, consulting engineer and chemist, of Hamilton, Ont.

THE Samuel D. Gross prize of $1,000, of the Philadelphia Academy of Surgery, was not awarded this year, as suitable contributions were not received, and the time has been extended to October 1, 1901. The prize is awarded every five years to the writer of the best original essay, not exceeding 150 printed pages, octavo, in length, illustrative of some subject in surgical pathology or surgical practice, founded upon original investigations, the candidates for the prize to be American citizens.

IN connection with the Geological Survey of Iowa, now in progress, Professor Macbride is attempting to present to the people of the State an accurate account of their all too slender forest resources. Appended to the report of the geology of each county, appears an annotated list of the arboreal species of plants found within the same limits, with special reference to the economic value of the several species and recommendations for the aid of farmers and others who may attempt tree-planting on an extensive scale. The latest issues are reports on Osceola, Dickinson and Dubuque Counties.

UNDER the auspicies of the Department of Agriculture and Technical Instruction for Ireland, the following demonstrations are to be given during the winter at the Dublin Museum: On 'Crocodiles, Snakes and Lizards,' and on 'Turtles and Tortoises,' by R. E. Scharff; on 'Lemurs and Monkeys,' and on 'Apes and Men,' by G. H. Carpenter; on 'Crabs and Lobsters,' by W. A. Cunnington; on 'Irish Sea-fishes,' and on the 'Economic Products of the Sea,' by A. Nichols; on 'Irish Shore and Sea-birds,' by C. J. Patten; on 'Flax-dodder and other Parasitic Plants,' and on 'Botanical Specimens for School Teaching,' by Professor Johnson; on 'The First Use of Metal in Europe,' by Mr. Coffey; on 'Writing Materials in Olden Times,' by Mr. Lyster; on 'Lace,' by Mr. Brenan; on 'Engraving,' by Mr. Strickland; on 'Clocks and Watches,' by Mr. Johnston; on 'Dutch XVIIIth Century Faience,' by Mr. Alabaster; on some objects from the Paris Exhibition, and on 'How to Visit a Museum,' by Colonel Plunkett, the director of the Museum.

THE Ohio State Academy of Science holds its tenth annual meeting at the Ohio State University Biological Hall, Columbus, Ohio, on December 26th and 27th, 1900.

THE usual December meeting of the New York Association of Biology Teachers was held, by invitation, at the Teachers College, Columbia University. The address of the evening was made by Professor F. E. Lloyd, the subject being 'Biological Exploration in the Mississippi Delta and Adjacent Islands.' At the close of the address an informal reception was held in the Laboratory of the Department of Biology.

AT a meeting of the Botanical Section of the Academy of Natural Sciences of Philadelphia, held on December 10, 1900, the following officers were elected: *Director*, Thomas Meehan; *Vice-Director*, Geo. M. Beringer; *Treasurer* and *Conservator*, Stewardson Brown; *Recorder*, John W. Harshberger; *Executive Committee*, Geo. M. Beringer, Thomas Meehan, Stewardson Brown, Jos. D. Crawford, Ida A. Keller.

THE next meeting of the Pan-American Medical Congress, over which the late Dr. William Pepper was to have presided, will be held at Havana from February 5th to 9th, 1901.

THE British Medical Association will hold its 69th annual meeting at Cheltenham from July 30th to August 2d, 1901: The 'Presidential Address' will be delivered by George Bagot Ferguson, M.D. The 'Address in Medicine' by James F. Goodhart, M.D., LL.D., consulting physician, Guy's Hospital. The 'Address in Surgery' by Sir William Thomson, M.D., LL.D., surgeon to the Richmond Surgical Hospital, Dublin, and surgeon in ordinary to the Queen in Ireland. The scientific business of the meeting will be conducted in thirteen sections. The names of the sections are as follows: A.—Medicine. B.—Surgery. C.—Obstetrics and Gynæcology. D.—State Medicine. E.—Psychological Medicine. F.—Anatomy and Physiology. G.—Pathology and Bacteriology. H.—Ophthalmology. I.—Diseases of Children. J.—Laryngology and Otology. K.—Tropical Diseases. L.—Navy, Army and Ambulance. M.—Dermatology.

PROFESSOR F. E. NIPHER, of St. Louis, writes that after many months of failure, he has succeeded in developing a fine reversed picture on the Cramer 'crown' plate, with the developing bath fully exposed to direct sunlight. The operation lasted a full half-hour, with no trace of fog. The details showed through the plate long before they came out sharply. The developer was a modification of the hydrochinone, the formula for which is given in every box of the Cramer plates. The bromide was left out, and the sodium carbonate solution was made up at half the strength used for negatives. The mixed developer was diluted with water in the proportion of one part to nine. This result is certain greatly to reduce the camera time.

A REPORT on the agricultural conditions of Porto Rico, transmitted to the House of Representatives by the President, on December 10th, recommends that an experiment station be established there. Secretary Wilson advises an appropriation of $15,000 to establish it, with an annual appropriation of $15,000 for maintenance.

A CURIOUS epidemic of neuritis has been afflicting many in the north of England, and (in spite of the fact that some teetotalers have suffered) has been traced to beer-drinking. The best founded opinion seems to be that which assigns it to the cheap sugar used in 'priming' the beer, since the sulphuric acid used in its manufacture is made from iron pyrites and contains traces of arsenic. Whatever may ultimately be fixed on as the deleterious agent, there will be an outcry for a return to malt and hops.

THE London *Times* reports that in addition to the British Antarctic expedition, there is also one in preparation in Sweden under the leadership of Dr. Otto Nordenskjöld, the well-known savant, who was a member of the Danish expedition to East Greenland last summer under Lieutenant Amdrup. Dr. Nordenskjöld has also shared in several Swedish polar expeditions. For the purpose of his Antarctic expedition he has acquired, for a nominal sum, the steam-whaler the *Antarctic*—an appropriate name—in which the Greenland voyage was performed. This vessel has quite an historical

Arctic record. It was built for whaling in the Greenland seas by a Norwegian firm, and has performed many voyages in polar waters. She was eventually acquired by Professor G. Nathorst, the celebrated geologist and Arctic voyager, who has shared in almost every Swedish polar expedition. Last year, again, the *Antarctic* was employed in the search for Andrée on the east coast of Greenland, when the owner himself was in command of the expedition, but which yielded no result. The vessel has thus again passed into Swedish hands. She was also engaged in an earlier voyage to the seas whence she derives her name by Norwegian speculators with the hope of reopening the famous whale fisheries in these parts, but the enterprise was an utter failure, not a single sperm whale being even seen. The vessel, which is in splendid condition for navigation in the pack-ice, and is, in fact, especially built for that purpose, will now proceed to Gothenburg for her final equipment. As she has cost so little Dr. Nordenskjöld estimates the cost of the expedition at only some £10,000 more. Of this sum one-half has already been contributed by Swedish subscribers, and King Oscar, with his well-known interest in Swedish explorations, has also promised a considerable amount towards the expedition, the first of its kind ever despatched from Sweden. Should circumstances permit, the Swedish expedition will, of course, cooperate with the British and German. It is hoped that the *Antarctic* may be ready to sail next August.

The sculptured decoration for the pediment above the four main entrances of the Ethnological Building at the Pan-American Exposition at Buffalo, is being modeled by Mr. H. A. MacNeil to represent the study of American ethnology. The original plan, suggested to him by Mr. Harlan I. Smith of the American Museum of Natural History, was to represent the inhabitants of the four quarters of North America and bring out the influence of the special environment of each. The idea was to represent upon the northern pediment the Eskimo, with his snow house, spliced bone arrow shafts, skin clothing and kayak, in a country barren of vegetation; upon the eastern pediment the Algonkin with snow-shedding steep-roofed bark hut, with canoes of wood or birch bark in a stream bordered by wild rice and forest; on the west the Kwakintl, with split plank house of immense size, with grotesquely carved totem pole, in a country of fog, rain and luxuriant vegetation; on the south the Zuni in a desert country, where steep roofs were unnecessary, but where pottery for carrying water reaches a high development. This plan had to be modified as the appropriation was for one model only and Mr. McNeil, in his desire to show something typically American, as contrasted with the usual classic decoration employed in museum architecture, and to represent the study of American peoples, has chosen two reclining emblematic figures, a woman on the left holding a pottery vessel and on the right a man in the act of measuring a human skull. These represent the study of man and his arts. Between these is a shield and a bird whose raised wings border it. This is emblematic of the food and clothing of the North. At the base are designs suggesting the highest culture of the South. In the lower right-hand corner is the prow of a birch bark canoe typifying the eastern Indian. These represent the environmentand materials for the study of American ethnology.

The first ordinary meeting of the Royal Geographical Society in the session 1900–1901 was held on November 12th, when Dr. A. Donaldson Smith read an account of his expedition through Somaliland and between Lake Rudolf and the Nile. Sir Clements Markham, president of the Society, occupied the chair, and in his introductory address, said, according to the London *Times*, that the most important geographical event since the close of the last session had been the return of the expedition of the Duke of the Abruzzi from Franz Josef Land. He had the great merit of having personally organized and fitted out the expedition in every detail, and an expedition had seldom sailed which had been so carefully and thoroughly equipped. Its geographical results were of great importance, for it had finally discovered the northern limits of the Franz Josef group, and confirmed Nansen's discovery of a deep ocean to the north; while the sledging party under Captain Cagni reached the highest northern latitude yet attained. If it could be arranged, the Duke of the Abruzzi would be pleased to give the Society an account of his expedition in the course of the session. The Danish expedition to East Greenland had also returned, after successfully continuing the work of Dr. Nathorst last year, while a Norwegian whaler was able to follow the coast of 75° 30′ N. Thus the dotted line which had so long indicated the supposed position of the East Greenland coast on our maps would now give place to a definite surveyed line, thanks chiefly to the persevering efforts of Danish geographers and explorers since the days of Graah. News of the expeditions of Sverdrup and Peary up Smith Sound was still anxiously awaited. The *Windward* went out to bring them succor, but she had not yet returned. The two recent expeditions to the Antarctic regions had both supplied us with valuable information. The British Antarctic expedition was now, at last, making progress as regards equipment and other arrangements. The ship was in an advanced state. Captain Scott, R.N., the commander of expedition, was only able to take charge last August, but he had already shown that he possessed many of those qualities which were essential for so difficult and responsible a post. The German expedition was far more advanced than the British in every department of its work, under the direction of its able and accomplished commander, von Drygalski; but this was because his committees had seen the wisdom of giving him a perfectly free hand. The commanders of the two expeditions had had an opportunity of becoming friends and of exchanging views during the autumn, and Captain Scott, if not too much trammelled by committees, would soon make up for lost time. Dr. Sven Hedin had during the past year been actively at work in the Lob-nor country and the basin of the Tarim, and his archeological discoveries would throw a flood of light on the past history of that region. In Africa the greatest amount of geographical work had been done this year. But a review of it must, alas! commence with a reference to the loss of a valued explorer. It was only last session that Captain Wellby's father read the account of his gallant son's splendid geographical achievement in marching from Abyssinia to the Nile. All would remember how they looked forward to welcoming him on his return from the front. Now that could never be. Captain Wellby had fallen fighting for his country. It was a glorious death, fitting close of an adventurous and active life. We were left to mourn the death of a young officer who was a great explorer and an ornament to the army. His noble example had been followed by others; for there had been remarkable activity in the exploration of Africa this year. Major Gibbons had followed Mr. Grogan from the Cape to Cairo. Mr. Moore had returned after his important investigation of the Central African lakes. Mr. Harrison had brought home an admirable map of the region between Lake Rudolf and Adis Abeba. The Society's gold medalist, M. Foreau, had safely returned after his wonderful journey across the Sahara, of which he had promised to send some account. Last, but certainly not least, Dr. Donaldson Smith, who was an old friend and known to all from his previous work, had made very remarkable journeys, involving new discoveries between Lake Rudolf and the Nile. He was glad to learn that serious steps had been taken under the Intelligence Department to carry out administrative surveys of all those territories in Africa which were directly dependent on the home Government, and that in conjunction with the other European powers which had African possessions.

Artists and art critics often claim that modern industrial conditions are unfavorable to the fine arts. In order to show that a more correct view is held in some quarters we quote the following note from the New York *Evening Post:* M. Arsène Alexandre, the well-known critic of art, discovered the much-talked-of *art moderne*, at the Paris Exposition, where one would least expect it to be—in the exhibit of locomotives. What appeared in a novel and striking light was not merely that these great machines had a beauty of line and proportion all their own, but that they showed a distinct beauty of racial type. The national character was clearly marked, in an American locomotive as distinguished from a French, a German or an English locomotive, and so of each as regarded the others. The critic found in the American machine a combination of elegance, practicality, convenience and power, which betokened a race that takes its ease in working. The English machine was more trim and smug, smaller, too, though with no loss of power; the German, similar, but a shade more pompous; the French, lighter and finer in line, but less powerful and effective. So as to the Russians, the Italians, and the Austrians, each locomotive not only had a beauty of its own, but was an impressive symbol of the national character. Returning after this voyage of exploration to the great international exposition of painting, M. Alexandre found a pervading sameness—most of the pictures might have been done in Rome, in Brooklyn, in Munich or in Paris, indifferently. It all seemed factitious—the output of a small international cult, not of great nations. The genuine art of the day was not here, but with the locomotives. The lover of art in its traditional forms will subscribe most reluctantly to M. Alexandre's allegory of the future of art. Yet no one can withhold a sentiment of admiration for this bold theory that the art of the future must grow unconsciously out of its most vital interests—not out of the fine arts in the traditional sense, but out of science and industry.

The British Consul at Stuttgart, in a report abstracted in the London *Times*, gives some interesting particulars respecting the growth of the acetylene gas industry, which he describes as one of the triumphs of German scientific industrialism. Five years ago calcium carbide was known only to trained chemists as an interesting chemical compound, and was quite unknown to the public. Now its production is one of the most important chemical industries. Germany was foremost to recognize the new illuminant, and it has secured the principal place in its production. At present there are at least 200,000 jets of acetylene gas in use in the country, and it is, the consul says, impossible to predict the result of the competition between it and its rival illuminants. Probably petroleum will suffer most; coal gas will be superseded to a great extent, especially in lighting small towns, but electricity will not be appreciably affected. No other branch of industry can point to such a large and steady increase in the number of patents, showing that it has encouraged great fertility of invention. Besides producing it at home, German capitalh as gone abroad to produce carbide, especially to Norway and Switzerland. One of the greatest successes of the industry has been its application to the lighting of railway carriages on German Government lines. During the current year the consumption of carbide in the country is estimated at 17,000 tons, equal in illuminating power to about seven millions of gallons of petroleum. Thirty-two small towns, with populations up to 5,000, are lighted by acetylene, and many more contemplate its adoption; and the progress of the system of lighting, says the Consul, is 'another striking instance of the manner in which the magnificent system of technical education has prepared the way for the introduction of new scientific achievements.' The economic importance of the industry appears from the fact that Germany annually pays about five millions sterling to the United States for petroleum, while acetylene is a purely German industry, carbide being manufactured in the country, which possesses in various parts all the necessary raw materials.

Professor E. Hitzig delivered on November 29th the second Hughlings Jackson lecture before the London Neurological Society. According to the London *Times* he discussed the present position of scientific knowledge concerning the psychical functions of the different parts of the surface of the brain. Since the experimental discovery in 1870 by the lecturer that a portion of the surface of the brain is divisible into separate areas or centers, each of which initiates and controls the movements of the various divisions of the body, many investigators had endeavored to solve the important questions, first, whether such areas or centers are really distinct psychical organizations, and, second, how such miniature psychical mechanisms act in relation to the phenomena of voluntary and automatic reactions respectively. A summary of the researches which have been made during the last thirty years establishes the truth of the view that such centers really exist, and that we now know definitely the precise spot in the brain which actively causes the movement of an arm and hand, for instance, when a voluntary action such as writing or drawing is executed. To students of psychology the further problem to be solved is how such centers act in relation to each other, and, above all, how far they are organizations for the reception of sensory impressions, as well as stations which issue outgoing orders, as it were, to the muscles. It is universally admitted that apperception must immediately precede all acts of so-called volition. This question the lecturer regarded as answered by the view that, at least in the carnivorous animals, brain conceptions and ideas of the movement to be performed by any part of the body are represented in the so-called motor center, which unquestionably is the starting point from which the final nerve impulse for the execution of that movement issues. After referring to the degree in which Dr. Jackson's original deductions have been confirmed by subsequent physiological as well as clinical investigations, Professor Hitzig dwelt on the fact that all workers in science are united in one camp in the battle against ignorance and against the opposition which some offer to the progress of natural knowledge. He felt that the invitation to him as a foreign investigator to deliver this lecture was an honorable expression of their common interests in their science.

UNIVERSITY AND EDUCATIONAL NEWS.

A circular letter issued by the Yale Bi-centennial Committee states that besides conditional pledges of $250,000, subscriptions to the amount of $900,000 have been received since the bi-centennial movement was started.

Fire in the main college building of the Iowa State College of Agriculture and Mechanic Arts destroyed on December 8th a large amount of valuable botanical material. The Parry herbarium was saved, except the duplicates which were nearly all burned. A part of the grass collection was saved and a few of the other specimens. The general collection contained about 80,000 specimens; more than 50,000 of these were burned, besides a large number of duplicate specimens numbering many thousands. Many valuable western plants collected by the writer, representing four years of labor, were destroyed. Also sets of plants from Porto Rico, Cuba, Mexico, Wyoming, Colorado and Texas were burned and much of the private library was also ruined, as well as the department library. Most of the microscopes and other apparatus were burned. Manuscript on grasses of the State, besides one on thistles and some smaller papers ready for publication, were also destroyed.

Myron L. Fuller, S.B., formerly instructor in geology at the Massachusetts Institute of Technology, is now an assistant geologist in the United States Geological Survey. He has been spending the summer in association with Mr. M. R. Campbell in the coal fields of western Pennsylvania, Ohio and Indiana. Charles H. Warren, Ph.D., has been appointed instructor in mineralogy and geology at the Institute in the place formerly occupied by Mr. Fuller. Dr. Warren was previously instructor in Professor S. L. Penfield's Laboratory in New Haven.

Mr. John Sealy Townsend, M.A., fellow of Trinity College, Cambridge, lecturer and demonstrator in the Cavendish Laboratory, has been appointed to the newly-established Wykeham professorship of physics at Oxford. Professor Townsend, as we learn from the London *Times*, was student and exhibitioner in the University of Dublin, where he was gold medalist in mathematics and physical science, and obtained the mathematical studentship of 1900, besides other prizes and distinctions. In 1896 he was appointed demonstrator in physics at the Cavendish Laboratory at Cambridge. He was Clerk-Maxwell scholar in 1899, and was elected to a fellowship at Trinity in the same year. The subjects of this chair, of which the income is provided from the revenues of New College, are electricity and magnetism, which are thus withdrawn from the province of the professor of experimental philosophy, by whom they have hitherto been taught. Merten College has contributed £700 towards fitting up, and £500 towards the maintenance of, a new electrical laboratory for the use of the professor.

It is announced that Sir William Muir, who is now 81 years of age, will shortly retire from the presidency of the University of Edinburgh.

SCIENCE

Friday, December 28, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PROGRESS IN FORESTRY UNDER STATE CONTROL.*

In the steps that are now being taken by the State of Michigan looking towards the establishment of a permanent forest policy the recent experience of other States cannot fail to be instructive. In the development of a great public movement in which so much is untried and unforeseen, mistakes are certain to occur, but the chance of their occurrence may be lessened by taking account of the history of similar movements elsewhere. Accordingly, the forestry laws of several States have been reviewed by the writer, and an attempt has also been made, from a comparison of these and a consideration of conditions there existing, to gather such hints as may be available in our own State. It has been thought best to limit this study to the five States, New York, New Jersey, Pennsylvania, Wisconsin and Minnesota, both because they approach Michigan more closely than others in physical conditions and because by far the greatest progress in the development of a forest policy has been made in those States.

The conditions in New England and the Southern Atlantic States are so far different from our own as to be valuable chiefly in a general way rather than in the solution of special problems; the great agricultural

* A review of forestry legislation and conditions in the Central and Northern States, prepared for the Michigan Forestry Commission.

States, Ohio, Indiana and Illinois have nothing to offer in this direction, while the Western prairies and the Pacific slope have their own peculiar and difficult problems, with which we are not immediately concerned. It is with the group of Central and North Central States that our lot is cast by nature, and though behind all of them in our care of the forest, we are nevertheless fortunate in being able to draw on their experience, albeit experience that has not passed the experimental stage.

NEW YORK. EARLY LEGISLATION.

The State of New York has been a pioneer in American forestry. In 1885 a law was enacted by the Legislature providing for the appointment of a forest commission with power to appoint a forest warden, forest inspector, a clerk and other agents. Provision was also made by the same Legislature for a forest preserve consisting of all the lands then owned or thereafter to be acquired in certain counties lying in the Adirondack and Catskill regions "to be forever kept as wild forest lands, not to be sold or leased, or taken by any person or corporation, public or private."

The forest commission was given control and superintendence of the forest preserve, and it was made its duty to maintain and protect the forests on the preserve, to promote as far as practicable the further growth of forests thereon, and in short to have charge of the public interests of the State with regard to forests and tree planting, and especially with reference to forest fires. Supervisors were made *ex-officio* protectors of lands in their townships, the forest commission having power to require, when necessary, that the supervisor appoint one or more forest guards to aid in the control of fire and otherwise.

The commission was also charged with preparing circulars of information and advice for the care of woodlands upon private lands and the starting of new plantations on lands denuded, exhausted, or injured by fire * * * or waste and unfit for other use, * * * these publications to be furnished without cost to any citizen of the State. The commission was unpaid, but the sum of fifteen thousand dollars was appropriated for the purposes of the act.

Considering the early date of this legislation, its comprehensiveness and the extent to which its main features have ever since been retained are alike remarkable. In the first place, the creation and maintenance of a forest preserve as the property of the State but controlled by a forest commission has from that time to this, for a decade and a half, been a central principle. Again, the forest commission, while charged with general responsibility, was expected to appoint officers who should be in immediate charge of actual forestry operations. This feature then embodied in the appointment of forest protectors is still retained in the far more developed system of the present time, in which the commission, not composed of experts, is represented in actual forest administration by the superintendent of forests assisted by other officials and employees. A third feature of the legislation of this early period was the attempt to utilize the services of persons already filling township offices in the enforcement of law, the supervisors, as already stated, being made *ex-officio* protectors of lands in their respective townships.

Subsequent experience, naturally enough, showed the necessity of certain changes even in legislation that embodied so much of permanent value. The provision for the control of forest fires, for example, was inadequate. Making supervisors *ex-officio* fire wardens could not, in the nature of the case, be made operative without strong pressure from a higher authority, and the employment of a commission without compensation, and accordingly without obligation to devote their entire time to the duties of their office, has given way to the more economical and productive policy of employing and paying men of trained efficiency in the administration of this branch of the public service. In still other particulars it has been found desirable to amend and extend the forestry law of 1885, as will appear in what follows.

Taxation, Sale and Purchase of State Lands.

At an early date the difficult problems connected with taxation, sale and purchase of State lands for forestry were taken up. The laws of 1886 provided that forest lands belonging to the State in the counties of the forest reserve should be taxed at the same rate as other lands, and that the tax should be paid by crediting the sum on the taxes due from each county in which they are located as State taxes.

In 1887 an Act was passed providing for the sale of detached portions of lands belonging to the State or their exchange for lands adjacent to land belonging to the State, and in 1890 the forest commission was authorized to purchase land within the counties including the forest preserve, for purposes of a State park, at a price not to exceed $1.50 per acre. During this time and for a period of several years thereafter the right of the State to much of the land belonging to the forest preserve was contested by parties having real or supposed claims, but the final decision of the highest court of appeal has left the State in possession with a title no longer open to question.

Parks.

In 1887 an Act was passed to establish parks for the propagation of deer and other game upon lands belonging to the State situated in the Catskill region, the forestry commission being authorized to set apart three tracts there for the purpose named, and by an Act of 1892 the Adirondack Park was established within the counties of the forest preserve lying in that part of the State, which it was provided 'should be forever reserved, * * * and cared for as ground open for the free use of all the people for their health or pleasure, and as forest lands necessary to the preservation of the headwaters of the chief rivers of the State and a future timber supply.' In both cases appropriations were made for the provisions of these acts, and the policy of State ownership and control of land for public parks, for sanitary purposes and water supply, and for raising timber as a function of the commonwealth was thus emphasized and confirmed.

Constitution and Duties of the Commission. Changes.

By an Act of 1893 the number of members of the Forest Commission, previously three, was changed to five. The commission was still unpaid, but was now empowered to employ a paid superintendent, two inspectors of forests, a secretary and clerks. Something further was now attempted in the way of fixing responsibility for the control of forest fires. The supervisors, besides being made town protectors of lands and *ex-officio* fire wardens, were required to report fires. But the uncertainty of promptly locating and extinguishing fires by means of untrained helpers, with other inherent difficulties that have been felt until the present time, prevented this system from accomplishing all the good for which it was intended.

In 1895 a change of considerable moment was made, the former commission being superseded by a Fisheries, Game and Forest Commission, consisting of five commissioners appointed by the Governor, their term of office being five years. The duties of the commission were now of far wider scope, and it was, of course, impossible for any member of it to be an expert in all of the various interests committed to its charge. A division of responsibility and labor, therefore, became at once necessary, and provision was accordingly made for the appointment of an engineer, 35 fish and game protectors and foresters, and various other officers and assistants.

Whatever advantage there may have been in this change as regards the general administration of these various interests, it would seem that at least in regard to what had formerly pertained to the forestry commission there was need of more specific provision for certain duties, and the following year (1896) an amendment was made to the law so as to provide for the appointment of fire wardens, one in each town, and the step thus taken towards the separation of the duties of game protectors from those of fire wardens has recently been carried still farther on the ground that more will be accomplished by this arrangement.

Forest Preserve Board.

Still in the direction of fixing responsibility for the performance of special duties, the law of 1897 provides that the Governor shall appoint three persons from the Forest, Fish and Game Commission and the commissioner of the Land Office as 'the forest-preserve board.' The duty of this board was to acquire for the State lands in the Adirondack Park as they might deem advisable for the interests of the State. Power was given to this board to enter on and take possession of any land, structures and waters in the territory embraced in the Adirondack Park as it might deem advisable for the interests of the State, with authority to adjust claims, and allow cutting of timber, with certain restrictions, by way of compensation; to take means for perfecting the title to lands held by the State, and to vigorously follow up and punish trespass of whatever kind.

For the purposes of this act the expenditure of one million dollars was authorized. In all, the State of New York has now expended about three million dollars in the purchase of land, making the forest preserve board the responsible agency for the purchase, validity of title, and, in short, the entire business connected with the bringing of these lands into the possession and control of the State. An indication of the long and vexatious struggle with claimants to State lands and the determined policy of the State with reference to these lands is seen in the law of 1898, which again gives the forest preserve board full authority for the State to determine the title to lands in the Adirondack Park, or the forest preserve, claimed by persons or corporations adversely to the State.

Forest, Fish and Game Law of 1900.

By this law the forest preserve is definitely limited, as are the Adirondack Park, the St. Lawrence reservation, and, less exactly, the deer parks of the Catskills. The powers of the commission, still composed of five members appointed by the Governor, include all the powers vested in the commissioner of the State land office and the Comptroller, on May 15, 1885, as well as those delegated in succeeding years to the forest commission and the forest preserve board, among which may be specially mentioned purchases in the Adirondack Park, actions for trespass, appointment of fire wardens and provision for instruction and popular information on the subject of forestry.

The office of superintendent of forests is made one of special responsibility, the incumbent being charged with the care and custody of the forest preserve, the prevention of forest fires and the general supervision of the forestry interests of the State. He is required to make an annual report to the commission showing the annual timber product of the Adirondack and Catskill forests, and also the extent of forest fires and losses, * * * with such other reports as may be necessary for the information of the commission. The duties of fire wardens and the prevention of fires along railroads and elsewhere, are entered into in much detail, and an evident necessity is provided for in requiring the appointment of a chief fire warden to have supervision of the town fire wardens, and by every available means to secure the prevention and the putting out of forest fires.

In reviewing the law of 1900 one is particularly impressed with the fact that it has been found necessary to entrust one man with the direct superintendence of the forest interests of the State, at the same time holding him responsible to a board of commissioners for the intelligent and faithful discharge of the duties of the office, also that for the control of fires one man is again held responsible, the chief fire warden having this as his special and single function. This definite fixing of responsibility can hardly fail to produce more satisfactory results. It is further noticeable that appointments to the commission are still for the term of five years, thus securing a permanent and consistent policy, and that the State now pays for this service as liberally as for other public work. In short, in the State of New York forestry has now become a recognized and permanent branch of the public service. Subsequent experience will doubtless suggest changes in methods of administration, but no interest of the State is more securely entrenched in law or more heartily sustained by public opinion.

School of Forestry. Practical Forestry in the Adirondacks.

New York has been the first State to establish a school of forestry. In 1898 a law was enacted providing for the establishment of a College of Forestry at Ithaca, in connection with Cornell University. Thirty thousand acres of land in the Adirondacks, for which the State paid $165,000 (including buildings), were set apart to be controlled by the university for a period of thirty years, at the end of which time the land is to become again the property of the State as part of the forest preserve. The sum of $10,000 was appropriated for the maintenance of the school, and liberal appropriations, namely, $30,000 for each of the first two years, have since been made for it. The trust was accepted by Cornell University, and Dr. B. E. Fernow, at that time chief of the Forestry Division of the U. S. Agricultural Department, was appointed director of the school. The school was promptly organized, instructors were appointed, and a course of instruction entered upon which has since been extended. Practical forestry operations have been conducted in the college forest since May, 1899, and students of the school are required to spend there a certain part of at least two vacations in the practical study of forestry.

The amount of work that has been accomplished in the college forest in less than a year and a half is surprising and in the highest degree encouraging. A survey of the property has been made, buildings have been erected and remodeled, a nursery has been established in which upwards of a million seedlings have been raised, the planting of a tract of burnt land with young pine and spruce has been completed, important experiments, such as planting in avenues opened in the forest, are in progress, and minute records are carefully kept as a basis for future study and practice. Most interesting of all, however, is the fact that extensive logging (by rail) operations have been begun under forestry principles, to remove the old hard-wood crop and replace it by a more valuable softwood crop in mixture with the hard woods. The thorough utilization of all the wood cut down to the mere brush, for all of which a market has been secured, is a novel feature of this logging, besides the care with which all young growth is saved. Moreover, the director expects that no further appropriations will be required, and that the experiment will at once become self-supporting through the profits from the logging operations.

It is too early to form a judgment regarding much of the practical work now in progress. The methods of European forestry are for the most part inapplicable here, and direct experiment becomes therefore the only means of determining the correct treatment of the forests. Mistakes must inevitably occur in a field where all is so new, and it is fortunate for other States that New York has organized such an experiment on so liberal a scale. None the less, it is certainly incumbent on the States with great forest interests of their own to provide for similar experimental study as soon as may be. Conditions vary; a method applicable in the Adirondacks may fail on the sandy tracts of Michigan or Wisconsin, and men must be trained on the ground in direct touch with the peculiar problems and difficulties that each section of the country presents. The New York College of Forestry is now equipped for the training of young men in the principles of forestry and in their practical application in that State, but their training must be supplemented by long-continued study of local conditions, and for this, as a least responsibility, the States interested should provide.

NEW JERSEY.

In New Jersey a considerable body of law has been enacted, especially with regard to forest fires, but without making special provision for its enforcement. As a result of this and of other causes the State has suffered greatly from fires. The coastal plain, where the fires have been most frequent, presents certain points of resemblance to the 'plains' of Michigan, and the extended study of that region which has been made in connection with the State Geological Survey is both instructive and suggestive.*

The 'plains' of New Jersey include approximately 20,000 acres of land lying in the northern extremity of the Atlantic coastal plain which extends from here to southern Florida. These plains are covered with a low bushy growth, much of it consisting of pitch-pine coppice (*Pinus rigida*) mixed with various other species. These plains are reported to have always been treeless, but there is every reason to suppose that this condition is due to repeated fires, since on the surrounding pine barrens may be observed all gradations from a healthy forest to scrubby plains. The soil of the plains, as indicated by chemical analysis, is richer than that of much of the surrounding region where good timber grows. Fire, therefore, is the agency that has rendered large tracts of land, as far as its present state is concerned, unfit for the raising of timber, and is even now converting other land into the same ruined condition. Just what course should be pursued with regard to lands that have already reached this condition is a problem in New Jersey as well as in Michigan. Meantime, the matter of immediate concern is to prevent further extension of such areas.

The means of suppressing these fires are discussed by Dr. Gifford, from whom I have already quoted. His most important suggestion is with regard to the multiplication of fire lanes, which experience has shown to be a successful barrier to ordinary fires. The good-roads movement is very strong in New Jersey, and every good road that is kept properly cleared becomes an effective fire lane. The same is true of railroads

*Gifford, 'Forestal Conditions and Sylvicultural Prospects of the Coastal Plain of New Jersey,' Munich, 1899.

along which combustible materials are kept cleaned up. In addition to this a suggestion with regard to 'forest farms' shows how the southern part of the State might be to a large extent divided up into farms in which the cultivated portion of each would surround a body of timber, which would then be isolated by a wide fire lane from other woodland, thus almost entirely obviating the danger of extensive fires. Suppose a person possesses one hundred acres of woodland out of which he wishes to make a combination forest and farm. The first step is to clear a fire lane around the whole of it, at least two hundred feet in width. This lane should constitute the cultivated portion of the farm. * * * If the hundred acres referred to is perfectly square, a fire lane two hundred feet wide around it would contain about thirty-five acres, as much as one man can comfortably till. There would be left in the center a forest containing about sixty-five acres. * * * If the whole area of woodland in southern Jersey were treated in this way, sixty-five per cent. would be left in wood and the whole would be cut up in such a way that extensive fires would be impossible.* The plan here suggested is apparently as capable of application, in a modified form, in Michigan as in New Jersey.

PENNSYLVANIA.

The history of the forestry movement in Pennsylvania is particularly instructive, since the conditions in that State are in various important particulars similar to, if not identical with, those prevailing in Michigan. Without attempting a complete review of earlier legislation in Pennsylvania, it is desirable to consider in some detail such important features as those pertaining to forest fires and forest reservations.

Early Legislation. Forest Fires.

As early as 1860 the setting on fire of woods or marshes to the loss of any other person was made a misdemeanor punishable by fine and imprisonment, and penalties were also provided for the cutting and removal of timber from the land of another. Failure to fix responsibility, however, made the law a dead letter, and it was followed by disastrous fires and by laxity of public sentiment in regard to them. An attempt was made in 1870 to remedy this by the enactment of a law requiring the commissioners of the several counties of the commonwealth to appoint persons under oath whose duty it should be to ferret out and bring to punishment all persons who either wilfully or otherwise cause the burning of timber lands, and to take means to have such fires extinguished, the expenses to be paid out of the county treasury, the unseated land tax to be first applied to such expenses.

Laws of 1897.

This law, like the former one, remained inoperative, or at least insufficient, until in 1897 it was amended so as to make the commissioners of the several counties responsible to the commissioner of forestry for compliance with its provisions, and prescribing a penalty of fine or imprisonment for failure. The expenses incurred in the employment of detectives were to be borne one-half by the county in which they were employed and one-half by the State. With this definite and not easily evaded responsibility, followed up by most determined and persistent effort on the part of the commissioner of forestry, real progress has been made. Offenders are lodged in jail with as great publicity as possible, and it is safe to say that public sentiment with regard to forest fires has never before in the history of Pennsylvania been formed so rapidly.

The same year, 1897, an act was passed making constables of townships *ex-officio* fire

* Gifford, l. c., p. 45.

wardens for the purpose of extinguishing forest fires, and requiring them to report to the court of their respective counties all violations of "any law now enacted or hereafter to be enacted for the purpose of protecting forests from fire" * * * with penalties for neglect of this duty. As before, the expense of carrying out its provisions was apportioned one-half to the county and one-half to the State, the limit under each act being $500 for any one county.

This legislation is of such recent date and the whole matter is so complicated and of such acknowledged difficulty, that it may well be questioned whether the best method of treatment has yet been attained; certain it is, however, that the present law marks a great advance upon preceding legislation and that its tendency, if enforced for a period of years, will be to more and more restrict both the number and extent of forest fires.

Forest Reservations.

In regard to forest reservations the legislation of 1897 includes two important acts. One of these authorizes the purchase by the commonwealth of unseated lands for the non-payment of taxes, for the purpose of creating a State forest reservation, requiring the commissioner of forestry to examine the location and character of the lands in question, and authorizing him to purchase them for the commonwealth if in his judgment they are available for the forest reservation. The other act provides for a commission of five members to locate three forestry reservations of not less than forty thousand acres each upon waters draining mainly into the Delaware, Susquehanna and Ohio rivers respectively, each of the reservations to be in one continuous area as far as practicable, and at least 50 per cent. of each reservation to have an average altitude of not less than six hundred feet above the level of the sea. The commission is empowered to take by right of eminent domain and condemn the lands as State reservations, the procedure in case of claim for damages being the same as already provided for the taking of land for the opening of roads in the respective counties in which the property is located.

Growth of Timber by Farmers.

A third series of enactments appearing in amended form in 1897 is designed to encourage the growth of timber by farmers. It is provided that in consideration of the public benefit to be derived from the retention of natural forest, the owners of land having on it forest or timber trees of not less than fifty trees to the acre, each measuring at least eight inches in diameter at a height of six feet from the ground, shall be entitled to receive annually during the period that the trees are maintained in sound condition a sum equal to eighty per cent. of all taxes annually assessed and paid upon said land, the eighty per cent. not to exceed 45 cents per acre, provided also that no one property owner shall be entitled to receive this sum on more than fifty acres.

In commenting upon this legislation the Commissioner of Forestry, Dr. J. T. Rothrock, says: "It should be readily perceived that these measures are directly in the interest of the farmer. In the first place, it is a partial removal of tax from land upon which he receives no revenue. In the second place, it is leading up to a lucrative timber crop at a minimum of expense to him, and in the third place, such land, when on a farm, is often on the highest and roughest part, overlooking the cultivated fields, and from its decaying leaves and humus a renewal of fertility is constantly washed down to the lower fields. * * * All of the above laws concern the individual more than the commonwealth. They are to make it possible for him to aid the State and at the same time to serve himself. Those which follow (with reference to forest reservations) mark a new era in our legislation. They reverse what has hitherto been the established policy of the State and aim at acquisition of timber land instead of sale of it. This change grows out of the now well-established fact that so long as the important watersheds of Pennsylvania are wholly under individual control there is serious danger to the interests of the community, and that, to safeguard these, the State must again possess itself as promptly as possible of these grounds.''

With regard to the public sentiment that has made such legislation possible the commissioner adds: ''There were grave doubts as to the passage of the bill (authorizing direct purchase of timber lands). But these soon disappeared, and it then for the first time became evident how strong and how general the sentiment in favor of the most active forestry legislation had become. The bill was passed by a large majority. It is clear that the State has at length earnestly entered upon the work of preserving its lumbering industries. The question is no longer whether it shall be done, but how it is to be accomplished. It is noteworthy that all political parties joined in this legislation, and also that the lumbermen, who once looked upon all forestry agitation as an interference with their business, have come to be among the warmest friends of the movement, which is intended to perpetuate, not to limit, their vocation.''

WISCONSIN. PRESENT STATUS.

Still nearer to Michigan, both in point of physical conditions and in the extent to which the forestry movement has crystallized into an active call for efficient legislation, is the neighboring State of Wisconsin. Climate and soil conditions are in many respects identical with our own. The northern half of the State has been lumbered extensively, has again and again been visited by destructive fires, and thousands of square miles have been left in what is apparently an utterly hopeless condition as regards agriculture and with a discouraging outlook as regards forest restoration. In a recent paper* the secretary of the State forestry commission has given a concise statement of the situation from which the following is reproduced.

Among the lessons to be learned from the history of the forestry bill of 1899, one of the most important is this, that there is no longer much danger of opposition to the principle that it is the duty of the State to provide for the permanency of forests by appropriate legislation, even to the extent of going into the business of conservative lumbering. Ten years ago such a proposition would have met with not a little hostility and ridicule. It would have been called impracticable, socialistic and un-American. In 1899 not a member of the Legislature, with a single exception, but admitted the desirability of such legislation. Even those who voted against the bill did so avowedly on the ground of expediency for the time being.

Even less opposition than within the Legislature is to be met with among the people of the State. Of course, there is a great deal of indifference and not a little misunderstanding of the aims and objects of forestry reform. In a State situated like Wisconsin, where the question of maintaining a water supply and preventing over-erosion is of subordinate importance, the great body of the people cannot be expected to feel the same direct interest in forest preservation as for instance in southern California, where the existence of agriculture is dependent on the maintenance of the mountain forests. In Wisconsin the

* Bruncken, 'On the Legislative Outlook for Forestry in Wisconsin.' Read before the American Forestry Association, July, 1900.

class most directly interested is that engaged in forest industries and manufacturing enterprises deriving raw material from the woods. It is very gratifying to the State that as a general rule men of this class are stanch friends of improved forestry, and some of the most energetic promoters of this cause, both in and out of the Legislature, are among the great lumbermen.

Of course, it cannot be expected that entire unanimity should exist as to the best means of reaching the desired end. In particular, the policy of placing considerable areas of forest land under State management is apt to encounter objections from the residents of the counties in which these forests will necessarily be located. They fear, on the one hand, that the reservation of those tracts will hinder the progress of settlement, and on the other hand, they desire to see all land in private hands, so that they may be taxed for the support of local government and improvements. Both these objections are, to be sure, based on imperfect knowledge, and are short-sighted enough. Yet they are made in good faith by men of intelligence, standing and influence. They must be overcome by practical reasoning and the spread of correct information.

Perhaps the most serious problem to be solved in Wisconsin, as well as its neighboring States, is what shall be done with the immense areas of denuded timber lands which are now growing up into vast wildernesses of worthless scrub, subject to the ravages of fire, and a constant menace to the standing timber adjoining. There are no physical obstacles to the reforestation of these tracts. But the financial and political difficulties are enormous. Most of these lands are the property of the lumber companies which harvested the timber. Not a little of it, however, has been sold for taxes and bid in by the counties. These do not know what to do with those lands, and from time to time sell them to speculators at nominal prices, sometimes for less than a dollar forty cents. Now there can be no question that much of the land of this kind is fairly good agricultural land, although it cannot be compared in quality with the hard-wood lands where the timber is still standing. But the greater portion is barren sand just good enough to bear a fair crop of pine, but unfit for agricultural crops after the slight accumulation of humus is exhausted. To persuade ignorant settlers to locate on such lands and to try to make them into farms is little short of a crime.

The great mass of the people of northern Wisconsin are well-meaning, upright folk, and they know well enough that much of this land is unfit for settlement. But it is not possible to draw a hard and fast line between the fit and unfit land, and the temptation is great to find invariably that the really unfit land is just beyond the boundaries of the next township. So the settlers continue to take up these sand barrens, with disastrous results to themselves and no permanent benefit to the community. The only feasible way to put these lands to the use for which they are adapted, and by which they can ultimately yield a profit, would be to place them in the hands of the State for rational forest management.

A number of owners of large tracts of land of this class have expressed their willingness to cede their holdings, which are practically valueless to them, to the State, if it will take proper care of them. It is probable that the solution of the problem will be approached from this direction. But in order to make this possible, some legislation will be needed, and for that purpose the friends of forestry in Wisconsin look forward to the meeting of the Legislature during the coming winter. There is the best possible reason to believe that a bill for the establishment of a rational forestry system will be passed by the next Legislature. It will be devised substantially on the lines laid out in the bill that failed of passage at the last session, with certain modifications, required by the rise of a new factor since the Legislature adjourned. The State University of Wisconsin has now under consideration a plan for the establishment of a forestry school as nearly as possible on the model set by the schools at Cornell and Yale. For this purpose the express authority and aid of the Legislature will probably be sought, and it is obviously proper to bring the State forest department and the State forestry college into as close relations as the difference between administrative and educational functions will permit.

MINNESOTA. FIRE WARDENS.

Minnesota has made very substantial progress in forestry legislation, especially in the direction of controlling forest fires. A most commendable feature of the law which has been in operation for five years, is the definite fixing of responsibility by the appointment of a chief fire warden who has general charge of the fire warden force of the State, and who is authorized during the dangerous season to use such means as he sees fit to prevent or suppress fires, the sum of $5,000 being available for this purpose. Supervisors of towns, mayors of cities and presidents of village councils are constituted fire wardens, with authority to arrest without warrant any person setting fire to woods or prairies to the danger of property, the wardens themselves being liable to penalties for neglecting the duties of their office. Under the vigorous administration of the present chief fire warden, much has been done to promote the growth of a correct public sentiment and not a little has been accomplished in the actual prevention and suppression of fires. Warning notices in great number have been posted and the intelligent cooperation of a large force of assistant wardens has been secured. During the drought in the early summer of the present year, over 300 fire wardens were in correspondence with their chief, reporting precautions taken, and otherwise showing their interest and activity. The system is doubtless capable of improvement, but in its inception and reasonably successful working a great step has been taken, and by so much Minnesota is well in advance of Michigan and Wisconsin.

Forest Reserves. State Forestry Board.

By the Legislature of 1899 an Act was passed designating as Forest Reserves lands set apart by the Legislature for forestry purposes, or granted to the State by the United States Government, or by individuals for such purposes, and creating a State Forestry Board to have the care and management of the forest reserves and to represent the State in all matters pertaining to forestry.

The constitution of the board has evidently been arranged with a view to making it non-political and as efficient as possible. It consists of nine members, including the chief fire warden, *ex officio*, the professor of horticulture in the State University, three persons recommended by the regents of the University on account of qualifications that are specified, and four to be recommended by the following bodies, namely: The Minnesota State Forestry Association, The Minnesota State Agricultural Society, The Minnesota Horticultural Society and the State Fish and Game Commission.

In creating such a board, authorized to accept lands for forestry purposes and to conduct forestry operations in the name of the State, including the sale of forest products, Minnesota has fully recognized forestry—not only from the protective, but also from the commercial point of view—as a proper function of the State. It is safe to say that this advanced position has the practically unanimous approval of the men in this country, few in number, to be sure, who are entitled to rank as forestry experts, and of other thoughtful students of the problems connected with this subject.

CONCLUSIONS.

From the foregoing review a number of suggestions may be drawn in regard to forestry problems in Michigan.

1. Necessity of legislation and State control.—There is no way in which satisfactory progress can be made until the State assumes responsibility. New York, Pennsylvania, and Minnesota have fully recognized this responsibility, and in each of them an efficient forestry service is maintained by the State. It should be noted that, especially in New York, where this service has been most developed, this fulfillment of its duty by the State, even at considerable expense, has the practically unanimous approval of its citizens. The opposition of selfish and irresponsible parties has been overcome and the State is to-day in peaceable possession of great forest areas of inestimable value, not merely for their timber, but as conservators of a pure water supply. The principle, therefore, has been fully established in this country as well as in the Old World that the protection and development of its forest for the benefit of its citizens, present and future, is a proper function and obligation of the State.

2. Form which legislation should take.—From the experience of other States, it would seem that one of the first steps to be taken would be the location, under the advice of competent experts, of such tracts of land as are better suited for forestry than for agricultural purposes, followed by proper measures for the acquisition of so much of these lands as may be deemed advisable. As large areas are already abandoned and have practically come into the possession of the State, the procedure, in many cases, would consist mainly in securing a valid and permanent title. The State of New York, as already pointed out, has a forest preserve board of three members specifically charged with the duty of acquiring lands for the State, with authority to take possession of lands, to adjust claims, and to take measures for perfecting the title of lands held by the State. In Pennsylvania a commission of five members has substantially the same duties, which are also shared by the Commissioner of Forestry. In this matter there is probably nothing better for Michigan than to follow in a general way the method adopted by these two States.

The control of forest fires presents one of the most difficult subjects with which Legislatures and forestry commissions have had to deal. In New York and Minnesota the appointment of a chief fire warden, who is paid for his services and is held responsible, marks a distinct advance, and the policy of Pennsylvania, of imposing and inflicting severe penalties for the setting of forest fires, has thus far been followed by good results. In any case the essential thing is the fixing of responsibility and provision for the execution of laws relating to fires. The first can only be attained by the appointment of responsible persons, and the second by paying for service rendered. None of the three States in which this has been done is likely to abandon this advanced policy for the more expensive one of allowing fires to sweep unchecked over its territory.

Thieves in some quarters of the State are worse than fires. An efficient trespass agent with adequate authority is the proper agency for holding the nuisance in check until it can be more radically dealt with. The repeal of the homestead law, earnestly advocated by those who have carefully studied the question, is apparently a necessary step in the suppression of this evil.

3. The utilization of educational institutions in the development of a rational system of forestry.—In this, again, New York is well in advance, although Connecticut has followed in the establishment of a school of forestry at its leading university, and in calling in the services of a trained forester whose work will be carried on in connection with the State experiment station. There can be no doubt that institutions of learning, endowed by public funds, owe to the State the best that they can contribute towards the solution of such problems of public interest, nor is there any doubt that these institutions, permanent in their nature and to a great degree free from political influences, are the best fitted to fulfill a duty in which a consistent policy and continuity of action are indispensable. Both the University and the Agricultural College of Michigan have recognized this duty and have cooperated in rendering such service as they have found practicable. There is still every reason for the continuance of this cooperation and for the enlargement of plans for further work. Should we follow in this the lead of Connecticut, which is similarly situated in the separation of the institutions directly concerned, there would fall to the University the establishment of a department of forestry devoted largely to investigation, while upon the Agricultural College would naturally devolve the care and further development of its experimental forestry stations. Should either or both institutions come into possession of extensive tracts of cut-over lands, with which it has been proposed to entrust them, these new possessions would furnish a series of problems the solution of which is quite as likely to prove of financial value to the State as to themselves. Profits must necessarily be relatively remote, but it is a matter of encouragement that the director of the New York School of Forestry, with but 30,000 acres of land on which to operate and the work barely under way, is confident that hereafter the forestry operations of which he has charge will be self-supporting, and it is the judgment of experienced lumbermen, as well as of scientific foresters, that in Michigan the conditions are such as to insure to the State, or to institutions that can afford to wait, a substantial profit from practical forestry.

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GEOLOGY AND GEOGRAPHY AT THE AMERICAN ASSOCIATION.

THE joint session of Section E of the American Association and the American Geological Society was opened on Monday, June 25th, in Schermerhorn Hall, Columbia University, to listen to the address of Vice-President Kemp, of Section E, on the 'Precambrian Sediments in the Adirondack Mountains.' This address, which has already been published in full in SCIENCE, July 20, 1900, was an exceedingly valuable and lucid contribution to the geology of this complicated but interesting region.

The first paper before the regular session of Tuesday morning was also one by Professor J. F. KEMP on the 'Local Geology about the City of New York,' which during the past several years has been studied in considerable detail by Dr. F. J. H. Merrill and others. This paper was given at the request of the 'sectional committee' and was preliminary to the three geological excursions arranged for and participated in by the members of Section E and of the Geological Society on the three following afternoons.

The second paper of the Tuesday morning session was by Mr. E. O. HOVEY, on the 'Geological and Paleontological Collections in the American Museum of Natural History,'* this paper having been prepared and presented at the request of the sectional committee preliminary to the visit of the members of Section E and of the Association at large to the American Museum on Tuesday evening.

Mr. F. H. Newell, in his paper on 'Hydrographic Surveys in New York,' described the objects and methods of this work as now carried on by the United States Geological Survey. One of the primary reasons urged for preserving the forests is the beneficial influence which they have upon the flow of the streams. The belief is widespread that the forest-cover conserves the waters, prevents floods, to a certain extent, and tends to increase summer flow, and that the cutting off of the forests has resulted in an increase of spring floods and in diminished flow during the summer droughts. All admit these influences, yet it has been extremely difficult to define the degree to which they are operative and to obtain convincing data for the support of conclusions.

It is important to know within reasonable limits to what extent the forests and other conditions influence the flow of streams; and the Division of Hydrography of the United States Geological Survey, cooperating with the Division of Forestry of the Department of Agriculture, is endeavoring to bring together facts upon which an answer to this important question can be based. The first step is to learn of the fluctuations of various rivers in different parts of the United States, to ascertain their regimen and to compare this with the cultural conditions of their drainage areas. To obtain these facts it is necessary that careful examinations be carried on through several years, so as to include periods of drought as well as those of excessive precipitation. For this purpose typical streams in various parts of the United States have been selected and stations have been established, at which the flow of the rivers is systematically measured. These river stations in many States, both east and west, cover almost every range of climatic condition from humid to arid. In the State of New York about 20 river stations are now being maintained, most of these being located on streams coming from the Adirondacks to form the upper Hudson, the Mohawk or the Black River. Cooperation in this work is maintained with the State Engineer and Surveyor, and also with the Forest, Fish and Game Commission recently appointed.

Diagrams showing the fluctuations of the streams from day to day throughout the year are prepared from the results of measurements, enabling a person to comprehend at a glance the great variation in volume of the streams under natural conditions. Knowing the changes which follow causes beyond the control of man, it should be possible to ascertain the relative importance of the fluctuations which result from artificial or controllable causes. It may require observations extending over a considerable length of time before we can definitely discriminate between effects produced by changes in the forest conditions; but however long the time or great the expense, it is of the first importance to ascertain these facts.

Mr. W J McGee's paper on the 'Occurrence of the Pensauken (?) Formation' within the limits of the city of Washington, brought out the following salient features: The commonly recognized geologic series in Washington and vicinity comprises, in descending order, (1) Later (low level, or fluvial) Columbia; (2) Earlier (high level, or interfluvial) Columbia; (3) Lafayette; (4) Chesapeake; (5) Pamunkey; and (6) Potomac. In a few localities, especially in the deep cutting in the 200-foot terrace at the head of Six-

*Published in Science.

teenth Street, deposits have been observed which fail to fit into this series. This cutting reveals, unconformably beneath the Earlier Columbia and uncomformably above the Potomac, a heavy deposit of loam and gravel of a structure, composition, texture and material simulating the Earlier Columbia formation in its normal aspect, save that the materials are more extensively disintegrated and decomposed. The resemblance of the deposit to the Earlier Columbia is such that it might readily be classed with that formation if found isolated; but in the Sixteenth Street exposure the two deposits are juxtaposed and separated by a well-defined unconformity—*i. e.*, the stratigraphy shows that the deposit in question is materially older than the earlier Columbia. On comparing the deposit with the Lafayette, as displayed in the nearest exposures of that formation on the west, north and east, it is found to be so different in materials and structure as to demand separation on lithologic grounds; moreover, the deposit is confined to a depression, or amphitheater, which did not exist at the time of Lafayette deposition, but was produced during the period of rapid degradation accompanying the post-Lafayette uplift; so that it must be discriminated from the Lafayette on the basis of homogeny as well as on that of lithology. The interpretation of the deposit is simple: it is evidently a record of an oscillation during the post-Lafayette and pre-Columbia time, which was not of such amplitude and length as to inscribe itself deeply in the local series of formations and land forms. On seeking to correlate the deposit with other elements in the coastal-plain series, difficulty is encountered; no corresponding deposits are known either southward or eastward in Virginia and Maryland; the nearest known deposits of corresponding character and position are a part of those found in southern New Jersey and first grouped by Salisbury under the designation Pensauken, but afterwards divided.

In Dr. JOHN M. CLARKE's paper on the 'Lenticular Deposits of the Oriskany Formation in New York,' this formation was described as attaining in eastern New York its greatest thickness south of Albany county, where it is highly calcareous and carries its normal fauna. In its extension through central and western New York its deposits are wholly arenaceous and siliceous and they alternately thin and thicken, thus forming a series of lenticular beds which are connected by thin sheets or wholly severed by the actual disappearance of the formation from the rock series. Beginning in Albany county, the formation has a thickness of but one or two feet, thence westward of Schoharie county it slightly thickens, and again thins and actually disappears in southern Herkimer county. Still farther westward at Oriskany Falls, the typical section, it attains a thickness of some 20 feet. At Manlius, Onondaga county, it has decreased to about one foot, and at Jamesville, five miles west, increases to three feet six inches. Four miles west of here, at Brighton, its thickness is one foot six inches, whence westward, at Elmwood, one mile and a half away, it thins to six inches. Again the formation disappears from the rock series, the eastern thinning edge of the next lens appearing first at Split Rock, near Syracuse, thickening towards Marcellus Falls, five miles away, and at Skaneateles Falls, six miles further west, attaining a cross-section of 18 feet; thence suddenly dropping to ten inches at Auburn, six miles still further west. This lenticular mass, designated the *Skaneateles lens*, appears to be the largest of these lenticular deposits west of Albany. From this point westward but two inconsiderable lenses are observable, the deposits being a thin sheet seldom over more than a few inches across.

This evidence is regarded as indicative

of an actual shore line during Oriskany time. No Helderbergian deposits occur in this western section of the State. The transgression of the Oriskany here is in conformity with similar evidence in other regions, of its wide extent beyond the limits of the preceding Helderbergian formation.

A second paper by Dr. J. M. Clarke, on 'The Fauna of the Arenaceous Lower Devonian of Aroostook County, Maine,' brought out the fact that a careful re-study of this fauna indicates that its proposed construction as a Silurian fauna correlating with the Tilestones of Murchison's Silurian section is not justified by the character and affiliation of its species. With such New York Oriskany species as *Anoplia nucleata, Cyrtina varia,* etc., it contains a number of species identical with those of Lower Devonian faunas of Western Europe. The faunas of the two localities of the Chapman Plantation, Edmund's Hill and Presque Isle Creek, have very little in common, but both show a close alliance with the arenaceous Lower Devonian faunas.

A paper on 'The Great Chisos Rift along the Canyons of the Rio Grande River,' by Professor R. T. Hill, and embodying the results of a trip by him through the lower portion of this canyon late in 1899, was one of unusual interest, as the region described was entirely new to the scientific world and one which proved to be varied and beautiful in scenery, and rich in geologic and topographic problems. The paper was illustrated by a considerable number of lantern slides prepared from photographs taken by Professor Hill during his journey.

In a short paper, 'Notes on the Geology of Central South Carolina,' Dr. D. S. Martin described the work about Columbia now being carried on by himself and Dr. L. C. Glenn, and the success of the latter in discovering eocene and cretaceous beds separating the 'Potomac' and 'Lafayette' deposits, which in many of the new railway cuts about Columbia are lithologically indistinguishable.

Dr. Alexis A. Julien read a paper on 'The Genesis of the Pegmatite in North Carolina,' in which he called attention to the constant association of vein and of dike phenomena, hitherto without satisfactory explanation in the pegmatite occurrences in the schists of that State and along the Appalachian belt. The several genetic hypotheses were reviewed, based on intrusion of fused magma, vein-infiltration, segregation and pneumatolytic introduction of igneo-aqueous magma. But none of these accounted for important facts observed, *e. g.*, vast pegmatite masses connected with almost capillary fissures, frequent distinct relationship of the material of the pegmatite and adjoining schists, and the almost universal banded structure and evidences of mineral concentration within the pegmatite. In their place he proposed the hypothesis of metasomatic aggregation, by molecular rearrangement of the entire material of portions of the schists in vicinity of fissures, through the action of mineralizers; lateral segregation within the igneo-aqueous magma or emulsion so formed, with production of vein-structure, etc.; crushing and even shearing, by orogenic movements, translation along the fissure-plane, partial obliteration of vein-structure and development of facies of a dike. On such an occurrence of pegmatite, therefore, one looks upon the birth of granite *in loco*, in at least one mode, rather than upon an intrusion of foreign material into cavities of discission or dissolution.

'The Geological Features of the Menominee Iron District of Michigan' were described in a short paper by W. S. Bailey, as occupying an area of about 120 square miles on the north side of the Menominee river, from Waucedah westward to a short distance beyond Iron Mountain. The ore-producing rock constitutes a trough between rims of basic volcanic rock on the south and granites and gneisses on the north. These are regarded as Archean in age. Between these rims lie two series of Huronian sediments separated by an unconformity. The lower Huronian sediments comprise in ascending order quartzites, dolomites and jasper. The upper Huronian beds are a jasper and ore formation, black slates, a second ore formation and gray slates. Over these unconformably lie horizontal beds of Lake Superior sandstone.

The ore formations consist of alternating beds of jasper, hematite and quartzites. The principal producing horizons are in the upper Huronian. The lower ore-bearing beds are mainly fragmental, and the upper ore-bearing beds are mainly altered crystalline sediments. The ore of the latter has come from iron carbonates, which have been decomposed as in the Marquette district, yielding cherts and hematite.

All of the Huronian rocks are strongly compressed and closely folded. The ores occur in pitching synclines with impervious bottoms. Geologically the Menominee district bears a striking resemblance to the Marquette district. The lower Huronian ore measures, however, which are large producers in the latter district, are scarcely known in the Menominee district, in which district the principal producing mines are in the lower ore formation of the upper Huronian.

In a paper on 'The Still Rivers of Western Connecticut,' Professor WM. H. HOBBS described the general course of the streams of this region as being to the south-southeast down the slope of the Cretaceous plain of erosion. In a few cases, however, large tributary streams are found flowing in nearly the opposite direction. Two notable instances of this sort have been studied, each bearing the name 'Still River'; and attention is thus directed to their exceptionally sluggish currents, due to the barely perceptible slope of their present beds. One of these streams rises near Tarrington, flows north-northeasterly past Winsted, and, after a course of about twelve miles, enters a branch of the Farmington at Robertsville. The other river of the same name, some twenty-five miles distant to the southwest, is a tributary of the Housatonic, having its source in a barrier of drift hills south of Bethel, flowing north northeasterly past Danbury and Brookfield, to enter its trunk stream just where the latter departs from the limestone valley to cut its way through gneiss.

In each case the course of the Still River has been determined by a belt of limestone within harder walls of gneiss and schist. The Still River, tributary to the Farmington, is, furthermore, an instance of reversal of drainage brought about by obstructions of glacial material.

In a paper on 'Drift Erosion, Transportation and Deposition,' by Mr. WARREN UPHAM, the work of the North American ice-sheet is described as threefold. Its erosion of the bed rocks, over the greater part of the glaciated area, is shown to have supplied far more drift than was desired from the preglacial residuary clay and river sand and gravel. Only near the borders of the ice-sheet, or to a distance of two or three hundred miles from it in the interior of this continent, the successive stages of fluctuating glaciation added each its drift deposits without general erosion of the underlying rocks or the earlier formed drift. The transportation of the drift appears to have been chiefly within the lower part of the ice-sheet, reaching in considerable amount at least 1,000 feet above the land surface on the mainly plain-like region of Minnesota and Manitoba. Its deposition for the greater part was directly from the ice, yielding the till and a large proportion of the mass of the moraines. Another large class of the drift formations shows modification by the waters of the melting ice surface and of rains, and is, therefore, called modified drift. These several phases of action and resulting deposits of the ice-sheet are discussed in the full paper, with illustrations from field observations, and from comparison with now existing glaciers and ice-sheets.

Professor C. W. Hall, in a paper on 'The Chengwatona Series of the Keweenawan' formation, describes this interesting series of volcanic rocks, first identified by Chamberlin as belonging to the Lake Superior copper-bearing formation. These rocks are exposed along the Snake River almost continuously for two miles, with edges 3 to 20 feet above the stream. The succession consists of basic eruptions (lava flows of typical structure) with intercalated conglomerates. The bottom of each flow is of very fine texture and in places apparently devitrified; the middle portion is of coarser yet quite uniform texture, while the top is strongly amygdaloidal with frequent tuffaceous phases. The recognition of the different phases of each flow and the transition from one flow to another can be distinctly seen, as the division planes are sharply drawn. In two or three instances the overlying tuff is thicker than the compact portion of the flow. The diabase is, for the most part, of the characteristic ophitic type, exposed surfaces first mottling and then becoming pitted through unequal decomposition. The amygdaloid carries the minerals characteristic of the Lake Superior basic eruptives with laumonite or some relative the predominant one. Lying interbedded with these diabase flows is a series of conglomerate beds; five were counted. They vary in thickness from 5 feet to 104 feet, and represent a total of more than 200 feet. Pebbles of gabbro, diabase, diabase porphyry, augite syenite and granite conglomerate are recognized, thus suggesting an age even later than tha of the augite syenite around Duluth, in other words, high up in the Keweenawan formation. The number of successive lava flows in the Chengwatona series is its most remarkable feature; not less than 45 were counted, and neither the top nor bottom flow was seen. The total thickness cannot be less than 10,000 feet actually in sight. The attitude of the entire series is uniform, and there is no sign throughout of sufficient displacement to duplicate a single flow. Besides, the conglomerate beds are so unlike in thickness that they cannot by error well be duplicated in the above estimate.

In a paper on 'A Simple Modeling Machine,' Dr. E. B. Mathews described a simple machine, designed by himself, of which many geologists and geographers have long felt a need.

The expense and great amount of time required to make simple relief models of areas studied by the existing methods have prevented geologists from making use of models in the representation of tentative geological interpretations. Moreover, the models made by cross sections, pegs or layer methods take much time and involve a high degree of personal equation in the sculpture. The machine described is a mechanical device for representing with considerable accuracy the territory included within a topographic atlas sheet. Two features are regarded of special importance: in such a machine, there must be rigidity in the horizontal plane in order to avoid distortion, and even greater rigidity in the vertical plane to eliminate vertical exaggeration. It was found possible to obtain the first by the use of a rigid pantograph in which the arms were about an inch and a half broad and three-eighths of an inch thick. The vertical accuracy is obtained by a stylus passing through the end of one arm of the pantograph and held at the desired height by two set screws, the whole resting on a free-moving support, and this in turn resting on two wooden knife edges. The pantograph is fixed to the top of a table from which a portion of the top has been removed. Below this opening is a depressed shelf on which is placed a tin box containing the plastic clay, which is of a thickness corresponding to the uniform base and the highest point to be represented. Beginning at the topmost contour the stylus traces the limits of that elevation. Outside of the line traced the clay may be removed to the first bench. In the same way all the contours may be followed by one arm of the pantograph and traced in clay by the other. The result is a rough representation of the shape of the county in which the surface is composed of a series of steps. These may be removed by a modeling wire and the whole given artistic life without changing the relative elevation of the different parts. It has been found possible to prepare this first relief model of a quadrangle in a day's time. From this it is possible to make the usual plaster matrices and thence the plaster relief according to the usual methods. The advantage of the machine lies in the speed by which the models may be produced and the elimination of the personal equation in the drawing of the heights.

In a short but interesting paper on 'Certain Late Pleistocene Loams in New Jersey and Adjacent States,' Professor R. D. SALISBURY presented the results of his numerous observations concerning the origin of certain recent loams found widely distributed in that region. These had been examined in hundreds of localities and found to be generally more or less local in character. Sections were exhibited showing its mode of occurrence near Jamesburg, Princeton, Trenton, Philadelphia, etc. The conclusions arrived at from these various examinations were that these loams are of marine origin and represent deposits made during a recent short period of submergence, which submergence in southeastern New Jersey extended to a depth of not less than 200 feet. The work of Professor Salisbury is the more interesting as it has an important bearing on the results of the study of somewhat similar surface loams and sands further south by Hilgard, McGee, Smith and Holmes.

In the paper on 'The Principles of Paleontologic Correlation' by Professor JAMES PERRIN SMITH, paleontologic correlation was described as being of two kinds: (1) Direct, where the faunal regions were closely connected and intermigration of species was easy. An example of this is the correlation of the Cretaceous of the Atlantic and Gulf regions with that of Europe; (2) Indirect, where the faunal regions were separated by land barriers. An example of this is the correlation of the Cretaceous of the west coast with that of the interior and Atlantic regions. These were separated by impassable barriers, but the Atlantic Cretaceous was connected with the European, the European with the Indian, and the Indian closely related to that of the west coast.

Oppel attempted to divide stratigraphic formations into faunal 'zones,' of which he made 30 in the Jura alone, most of which cannot be recognized in outside regions. Buckman divided the Jura into *hemeræ*, of which he found 26 in the Lias alone. These, too, can not be recognized away from the province where they were founded. But, occasionally, the fauna of a certain horizon can be identified in very remote regions, this extension corresponding to periods of unrest, of oscillations of the land and opening up of connections between regions that before were separated. The writer proposes to confine the term *zone* to such widely distributed faunas, which thus become important criteria in interregional correlation. Such zones are that of *Manticoceras intermerceras* in the upper Devonian, of *Agamides rotatorius* in the Kinderhook, of *Gastrioceras listeri* in the middle coal measures, etc.

The principles governing the migration of marine invertebrates were discussed, and the reality of 'colonies' affirmed. Homotaxis, as defined by Huxley, was discussed, and it was shown that even now similar faunas are living synchronously in widely separated regions, and that the same could have happened, and probably did, in past time. Therefore, correlation is often real, and not merely homotaxial. The strata coming between the interregional zones are, in a sense, only homotaxial, but the zonal faunas themselves often represent synchronous appearances of immigrants in two or more regions from a third unknown point of origin. The substantial agreement of the stratigraphic column in all the continents is the best possible proof of the reality of correlation, for the discrepancies that occur in the periods of endemic development are all corrected in the periods of readjustment, and nature's periodic trial balances bring into harmony the record in the interregional time scale.

The following additional papers were presented before the Section, all except the first two being under the auspices of the Geological Society:

The Ice Age in New Zealand: C. H. Hitchcock. (With lantern slides.)

On a New or hitherto Unrecognized Horizon in the Lower Portion of the Devonian System in Eastern Canada: Henry M. Ami.

Native Copper from Garfield County, Oklahoma: Erasmus Haworth.

Petrographic Studies on the Andesitic Rocks of Silverton, Colorado, with Analyses by W. G. Haldane and E. W. Gebhardt: Frank R. Van Horn.

The Hudson River Beds of the Vicinity of Albany, and their Taxonomic Equivalents: Rudolf Ruedemann. (Introduced by J. M. Clarke.)

Giants' Kettles Eroded by Moulin Torrents: Warren Upham.

Pleistocene Ice and River Erosion in the St. Croix Valley of Minnesota and Wisconsin: Warren Upham.

Evidences of Interglacial Deposits in the Connecticut Valley: Charles H. Hitchcock.

Volcanic Phenomena on Hawaii: Charles H. Hitchcock.

A Theory of the Origin of Systems of nearly Vertical Faults, with Application to the Newark Basin of the Pomperaug River: W. H. Hobbs.

EXCURSIONS.

The following excursions were arranged for and participated in by the members of Section E and of the Geological Society:

Tuesday afternoon.—Under the leadership of Professor Kemp, the crystalline rocks in that portion of New York City east and north of the Columbia University buildings were visited and carefully examined. The interbedded arrangement of the limestones and gneisses indicated clearly the sedimentary origin of these materials.

Wednesday afternoon.—Under the leadership of Professor Kemp, the grounds in the Botanical and Zoological Gardens were visited, and careful attention on the part of the members was given both to the character of the crystalline rocks and to the later surface phenomena, including potholes, the glacial deposits and the new and old Bronx River channels.

Thursday afternoon.—Under the leadership of Dr. A. A. Julien, a visit was made to the Palisades along the west bank of the Hudson for the purpose of studying the geologic and topographic relations there, and for the further purpose of seeing the extent to which the Palisades were being injured by the extensive quarrying now in operation for the purpose of securing road metal.

J. A. Holmes,
Secretary of the Section.

THE NEW CHEMICAL LABORATORY OF THE UNIVERSITY OF KANSAS.

As a new laboratory has been constructed during the past year at Lawrence, to accommodate the departments of chemistry and pharmacy, some facts in regard to the building, and the appliances furnished, may be of value to others who contemplate erecting buildings for this purpose.

The material used, as shown in the cut, is native limestone, laid in horizontal courses with recessed pointing. A large portion of this was quarried on the site, as the upper courses of rock were removed in order to obtain a solid foundation on the lowest of a series of ledges. Some of the courses in the excavation were of light stone, while others were colored yellowish by iron oxid ; the light rocks are used for the outside layers, except on the back side, and the yellow rocks for interior filling. For trimmings, a limestone, known as Jefferson County, which occurs in ledges something over a foot in thickness, within a few miles of the city, is utilized.

Chemical Laboratories. South Front.

The plans were drawn by J. G. Haskell, architect, and the director of the laboratory with the assistance of his colleagues, after personal inspection and study of many of the largest and best appointed chemical laboratories in the country. The building is plain and massive in construction, and while very little was expended for adornment, no expense was spared to secure the best practical conditions for chemical and pharmaceutical work, according to modern methods.

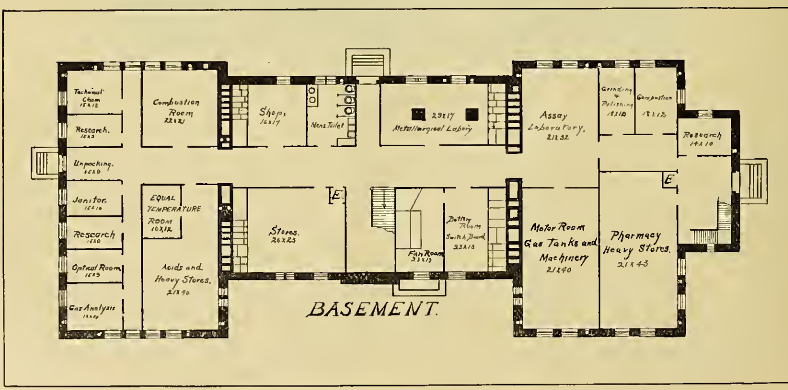
The length of the building is 187 feet and the greatest breadth 70 feet, with a central portion devoted to offices, private laboratories, etc., and two wings for larger laboratories and lecture rooms. Below the basement floor there is a plenum four feet in depth, and as the building is upon the side of the hill, three sides of the basement are above the ground, and well lighted. Each of the three other stories is twelve feet in height, and the attic is commodious and well lighted.

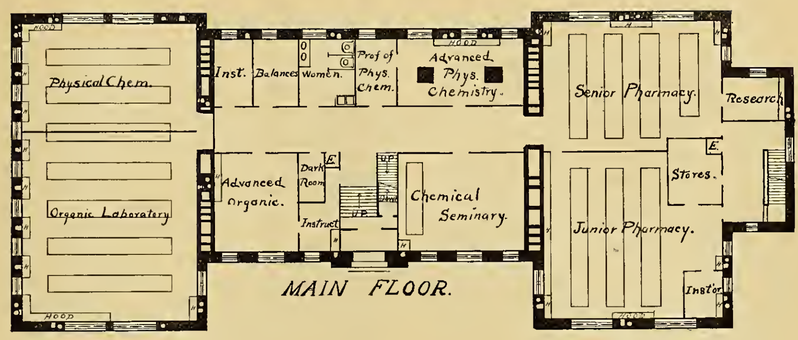
As the so-called mill construction is used throughout the building, the joists and ceilings are finished with shellac and hard oil, and the double floors, which are made of one

In the Qualitative Laboratory.

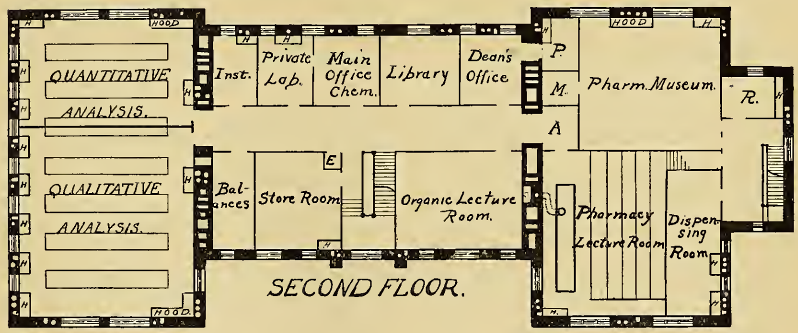
and one-fourth inch hard pine, are separated by a half-inch air space and tarred paper. The corridors are twelve feet wide, and the walls, instead of being built of stone, are of wood, with the spaces between the studs 'nogged' with brick. The building is plastered with 'cement plaster.' At each end of the central portion of the building, as shown in the floor plans, is a four-foot brick wall, which carries the heating flues, and some ventilating flues, where there is space available for them.

The system of heating and ventilation, which has been arranged with special care, includes a fan blower driven by a $11\frac{1}{2}$ K. W., direct current, electric motor; primary coils having 1,900 feet radiating sur-





MAIN FLOOR.



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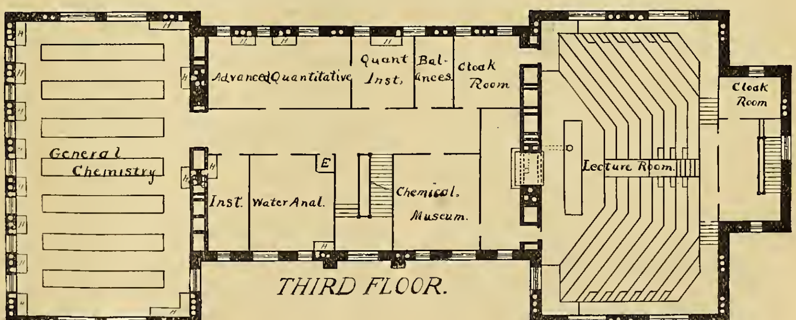

THIRD FLOOR.

face through which the air is drawn and 'tempered'; and secondary coils at the base of the brick walls above mentioned. By means of dampers, which are operated from the several rooms, either tempered or heated air can be discharged into rooms, and thus an abundant supply of fresh air is always assured. This system is completed by removing the foul air from the rooms by means of nine-inch circular tiles connected with the hoods, which are placed between the windows, and indeed at every other point where there is available wall space. There is an eight-inch opening near the bottom of the hood, and a five-inch opening near the top, and the tiles terminate above the peak of the roof, each hood being ventilated by an independent flue, and those flues are grouped into brick chimneys. The construction of the hoods may be understood from the cut of the interior. There are no pipes for gas, water or waste in the hoods, as these are all carried outside and below the floor of the hood.

Referring to the floor plans which are here shown, it will be noticed that there is a separate entrance in the east wing to the pharmacy laboratories on the first floor, the laboratory for pharmacognosy, the pharmaceutical lecture room, with preparation room attached, and the model drug store on the second floor. This same entrance leads to the large chemical lecture room on the third floor, which is arranged to accommodate 325 students. Attached to this lecture room, is a commodious preparation room, and communicating with it is also a chemical museum.

In the west wing are situated the large laboratories of the department of chemistry; on the top floor, that for general chemistry, on the second floor, those for qualitative and quantitative analysis and on the first floor, those for organic and physical chemistry. Each floor accommodates 224 students, one-half working at a time. The basement will be used for special research rooms, assay and metallurgical laboratories, and store rooms.

The offices of the professors of chemistry and of pharmacy and their private laboratories, are on the second floor, so as to be as convenient as possible to all parts of the building, and on the same floor is a library, a balance room, a store room for the dispensing of chemicals and apparatus, and a recitation room which will accommodate seventy-five students. An elevator connects the basement stock room with the store room, and extends to the attic, while a similar elevator at the east end accommodates the pharmacy department.

On the first floor is a smaller laboratory for advanced organic chemistry, with a private laboratory for the instructor, a balance room, lavatory, dark room, a smaller laboratory for physical chemistry, with an office for the instructor adjoining, and a seminary room.

The students' tables in the main laboratories are substantially built of yellow pine, paneled, full one and a-quarter inches thick. Each student is provided with a locker and two drawers, all fastened with a rod which passes through the drawers and is secured by a padlock. At the right or left of each student is a deep sink, twelve inches by thirteen, with a pantry cock for delivering water. Underneath a low bottle rack, which stands on the table, a sufficient number of four-way gas cocks are placed. The panel under the sink is movable, and in this opening the gas, water and waste pipes are brought up through the floor. As the gas pipe is led in a groove along the table under the movable bottle rack, every pipe is easily reached in case of a leak.

The two-inch table top is stained black with an anilin dye, which is not readily acted on by acids or alkalies.

Since the large laboratories are placed one above the other, they can be supplied by the same system of pipes, and the drainage of the sinks is simple and not liable to get out of order. The drain pipes connect with four-inch delivery pipes on each side of the room, by sanitary T's, and these discharge into soil pipes in the corners. All the drainage is thus taken from the building by four pipes provided with traps, with an additional sewer pipe, of course, to drain the lavatories.

The plan of the building also provides for a system of high pressure steam pipes from the university engineering shops, for blast and vacuum pipes for each room, and for distilled water to be prepared in the attic by boiling water with the high pressure steam. The distilled water is then conveyed to the different laboratories by means of block tin pipes.

There has been expended upon the building the sum of $55,000, leaving some of the less important rooms unfinished, and the furnishings in others incomplete. It is estimated that when the building is completely furnished, as the plans provide, the total cost will be about $80,000.

In the construction of this laboratory no great originality is claimed, but the effort has been made to combine the best features of several of our most modern buildings, as far as this could be done at moderate expense. So far as tested the arrangements for heating and ventilation, perhaps the most important points in laboratory construction, which have some novel features, seem to be very effective. It is believed that greater utility can with difficulty be secured anywhere at the same cost.

E. H. S. BAILEY.

SCIENTIFIC BOOKS.

A Treatise on the Theory of Screws. By SIR ROBERT STAWELL BALL, LL.D., F.R.S., Lowndean Professor of Astronomy and Geometry in the University of Cambridge. Cambridge, The University Press; New York, The Macmillan Company. 1900. Pp. xix + 544, quarto.

Ball's famous work was first given to the world in 1876; later (1889), in a German treatise edited by Gravelius with Ball's cooperation and additions by the editor. Both of these having become inadequate, the present monumental publication, containing a systematic presentation of the present state of knowledge on the subject, was undertaken and completed by the original author. The theory of screws in relation to rigid dynamics begins, on the one hand, with the kinematic theorem of Chasles, that any displacement of a rigid body may be reached by a translation along a definite line called the central axis, and a rotation around it; and on the other hand with the dynamic theorem of Poinsot, that any number of forces or of torques actuating a rigid body in any way may be reduced to a single force and a single couple (collectively a wrench), with the axis of the latter parallel to the direction of the former. The reasoning thence is naturally along the lines of modern geometry or of quaternions, for a screw is a linear magnitude with a definite unit called pitch (advance per radian) associated with it. A twist thus bears the same relation to a rigid body that a vector does to a point. Hence the reader wishing to derive full advantage from Ball's great treatise must be familiar with the modern treatment of geometry. A good account of Ball's theory is given in Schell's 'Theorie der Bewegung und der Kräfte' (Vol. II., Chapter VIII.), as well as in Routh's 'Treatise on Analytical Statics.' However, such is the lucidity of Ball's style, that the reader who knows only the ordinary dynamic methods will find the book accessible somewhere in almost all parts except those specially devoted to higher geometry.

The chapters follow an orderly development: After the fundamental principles are laid down in the first five chapters, equilibrium, inertia, potential, harmonic motion are successively discussed in the four chapters following. Thereafter the six orders of freedom are treated consecutively in nine chapters. The eight remaining chapters deal with the higher development of the subject in ordinary as well as in non-euclidean space. The generality of the methods will be seen even when the scope of the investigations is limited to conservative forces and infinitely small displacements, for the form of the body does not enter the discussions.

To give an analysis of the book or of Ball's method would be presumption, as Ball did this himself in his inimitable address before the British Association at the Manchester Meeting in 1887, reprinted in *Nature* of the same year, as many of the readers of SCIENCE will remember. Though the address is fourteen quarto pages long, it preserves its exquisite flavor throughout. Ball begins thus: "There was once a rigid body which lay peacefully at rest. A committee of natural philosophers was appointed to make an experimental and rational inquiry into the dynamics of that body. The committee received special instructions. They were to find out why the body remained at rest, notwithstanding that certain forces were in action. They were to apply impulsive forces and observe how the body would begin to move. They were also to investigate the small oscillations. These being settled, they were then to—but here the chairman interposed; he considered that for the present, at least, there was sufficient work in prospect. He pointed out how the questions already proposed just completed a natural group. 'Let it suffice for us,' he said, 'to experiment upon the dynamics of this body so long as it remains in or near to the position it now occupies. We may leave to some more ambitious committee the task of following the body in all conceivable gyrations through the universe.' "

"The committee was judiciously chosen. Mr. Anharmonic undertook the geometry. He was found to be of the utmost value in the more delicate parts of the work, though his colleagues thought him rather prosy at times. He was much aided by his two friends, Mr. One-to-one, who had charge of the homographic department, and Mr. Helix, whose labors will be seen to be of much importance. As a most respectable, if rather old fashioned member, Mr. Cartesian was added to the committee, but his antiquated tactics were quite outmanœuvered by those of Helix and One-to-one. I need only mention two more names. Mr. Commonsense was, of course, present as an *ex officio* member, and valuable service was rendered even by Mr. Querulous, who objected at first to serve on the committee at all. He said that the inquiry was all nonsense, because everybody knew as much as they wished to know about the dynamics of a rigid body. The subject was as old as the hills, and had all been settled long ago. He was persuaded, however, to look in occasionally. It will appear that a remarkable result of the labors of the committee was the conversion of Mr. Querulous himself.

"The committee assembled in the presence of the rigid body to commence their memorable labors. There was the body at rest, a huge amorphous mass, with no regularity in its shape—no uniformity in its texture. But what chiefly alarmed the committee was the bewildering nature of the constraints by which the movements of the body were hampered. They had been accustomed to nice mechanical problems, in which a smooth body lay on a smooth table, * * * in fact the chairman truly appreciated the situation when he said the *constraints were of a perfectly general type*." Later in the proceedings Mr. Querulous is heard from. " 'How could you,' he said, 'make any geometrical theory of the mobility of the body without knowing all about the constraints? And yet you are attempting to do so with perfectly general constraints of which you know nothing.' " The committee having got to work assigned certain duties, whereupon that 'most respectable if rather old fashioned member,' gives an account of himself: "Mr. Cartesian having a reputation for such work, was requested to undertake the inquiry and report to the committee. Cartesian commenced operations in accordance with the well known traditions of his craft. He erected a cumbrous apparatus which he called his three rectangular axes. He then attempted to push the body parallel to one of these axes but it would not stir. He tried to move the body parallel to each of the other axes but was again unsuccessful. He then attached the body to one of the axes and tried to effect a rotation around that axis. Again he failed for the constraints were of too elaborate a type to accommodate themselves to Mr. Cartesian's crude notions."

After further elaborate proceedings, "'Is this all?' asks the chairman. 'Oh no,' replied Mr. Cartesian, 'there are other proportions in which the ingredients may be combined so as to produce a possible movement,' and he was proceeding to state them when Mr. Commonsense interposed. 'Stop! Stop!' said he, 'I can make nothing out of all these figures. This jargon about x, y and z, may suffice for your calculations, but it fails to convey to my mind any clear or concise notion of the movements which the body is free to make.'"

So we might continue quoting every paragraph of this amusing but seriously constructed essay, with equal zest. The book closes with an elaborate bibliography containing all the work relating to the theory of screws from its inception with Poinsot, Chasles, Grassmann, Hamilton, Möbius and Plücker, to the modern advances of Clifford, Klein and their confrères and Ball himself.

CARL BARUS.

BROWN UNIVERSITY.

TOPOGRAPHIC ATLAS OF THE UNITED STATES.

The second folio of what promises to be a magnificent topographic atlas of the United States, published by the United States Geological Survey, has recently been issued. This second number, like the first, bears Henry Gannett's name, and like its predecessor, also presents illustrations of typical topographic forms for the use primarily of students and teachers of physiography. From the large number of topographic sheets issued by the Geological Survey, ten have been selected which furnish admirable examples of well-developed physiographic features, such as a coastal swamp, a graded river, Appalachian ridges, alluvial cones, etc., and bound in a folio, together with brief descriptions and explanations.

The maps have been well selected and in themselves, so far as one can judge who is not intimately acquainted with the areas represented, are all that could be desired. Not only does the field-work seem to have been carefully executed, but the engraving and printing is excellent.

The text accompanying each map is intended to supplement and explain the topographic and culture features shown on it. These descriptions are for the most part evidently compilations from the writings of geologists and geographers, who have studied the areas represented or other similar regions, although no acknowledgments of the sources of information are made. Such references are much to be desired not only in justice to the original investigators, but for the purpose of directing the reader to sources of more extended information. In some instances the maps chosen represent topographic forms which have been carefully studied elsewhere, and might profitably be accompanied by citations from the descriptions of the type examples. Such references and citations could easily be made, as the printed text seldom occupies an entire page: in fact much valuable space is wasted.

Instructive and pronounced features on some of the maps are not referred to in the text, although there is space available. For example, in the description of the Norfolk sheet, the origin of the drowned stream valley, the prominent hills near the ocean's shore presumably dunes, and well-marked characteristics of the shore topography, due to the action of waves and currents, are not mentioned, but in place of such information a questionable explanation of the origin of Lake Drummond is presented. Again, in the text accompanying the excellent map of alluvial cones, no reference is made to the conspicuous channels excavated in their upper portions.

The pictures in the text are poorly printed, and one of them bearing the objectionable name of 'hogback,' is reversed in reference to right and left; this reversion throws the picture out of harmony with the diagram beneath it, intended to show the structure on which the monoclinal ridge depends. In the title of the picture just referred to—and the same is true in at least one other instance—no reference is made to the geographical position of the scene represented.

The diagram described as a 'volcanic neck,' might be accepted as representing a cross-section of a peculiar plutonic intrusion, but by no stretch of the imagination can it be considered as illustrating the structure of a volcanic neck. In attempting to indicate the 'stratified beds now eroded away' they are carried completely over the intruded mass labeled 'lava,' seemingly with the intention of indicating that the intrusion did not reach the surface. We know, however, from the writings of Major Dutton that the volcanic necks in the Mt. Taylor region, the one selected, are the plugs hardened in the throats of normal craters.

An exception might be taken to the use of the word *crater* in reference to the great depression in the summit of Mount Mazama, but such a distinction I believe, was not made by Dutton and Diller, to whom we owe nearly all our information concerning the region in question.

In the interest of the large number of teachers and students who will consult the topographic folios of the U. S. Geological Survey, I venture to suggest that the descriptions accompanying the maps should be written by persons who are familiar with the regions represented and have a critical knowledge of their geology. These texts, although of necessity brief, should not be stultified compilations, but Nature herself speaking through a master interpreter.

ISRAEL C. RUSSELL.
UNIVERSITY OF MICHIGAN.

BOOKS RECEIVED.

Animal Life. DAVID STARR JORDAN and VERNON L. KELLOGG. New York. D. Appleton & Co. 1900. Pp. ix+329.

William Herschel and his Work. JAMES SIME. New York. Charles Scribner's Sons. 1900. Pp. vii+265. $1.25.

The Teaching of Mathematics in the Higher Schools of Prussia. J. W. A. YOUNG. Longmans, Green & Co. New York, London and Bombay. 1900. Pp. xiv+141.

Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere. ARNOLD LANG. Second revised edition. First part, *Mollusca.* KARL HESCHELER, Jena. Gustav Fisher, 1900. Pp. viii+509.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of School Geography, edited by Richard E. Dodge, of Teachers College, Columbia University, enters upon its fifth volume in January. The editorial staff will be strengthened by the addition of Mr. Mark S. W. Jefferson, of the High School, Brockton, Mass., who will devote his attention to Secondary School Geography, and of Miss Ellen C. Semple, of Louisville, Kentucky, who will, as before, contribute articles and notes in reference to Anthropo-geography.

The Plant World for November opens with an illustrated article on 'An Ornamental Species of *Bidens*' by G. N. Collins. It is a little irregular to learn that the now popular *Cosmos* flower was brought from Mexico twenty years ago and cast aside as a worthless weed. F. M. Burglehaus tells of 'Drying Botanical Dryers in Wet Weather' and Charles Newton Gould describes the 'Jack Oaks in Oklahoma' which are practically useless for anything save firewood. Charles A. White discusses 'The Varietal Fruit Characters of Plants' and 'English and American Weeds [are] Compared' by Byron D. Halsted with the result that in 100 species from each region less than one quarter of them are common to both lists. In the Supplement devoted to 'The Families of Flowering Plants,' Charles Louis Pollard treats of the orders Fogales, Urticales and Proteales.

No. 38, vol. 8, of the *Bulletin of the New York State Museum* is devoted to a 'Key to the Land Mammals of Northeastern North America' by Gerrit S. Miller, Jr., intended to furnish a ready means of identification with the least possible technical requirements. Keys are furnished to the various orders, families, genera, species and even subspecies of the mammals inhabiting the region noted, while references are given to the first publication of each name, the first use of the binomial or trinomial combination and to some recent work in which the animal is described in detail. Recently extirpated animals, such as the bison and walrus, are included and there is a short introduction defining the areas of the life zones of the region under consideration, and before the 'Key' proper is a check list of the 105 species treated. The work is not only useful for the amateur, but of great value to the working zoologist, as Mr. Miller is among our leading authorities on mammals and has devoted particular attention to those of New York State and the adjoining territory.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 106th regular meeting was held December 12th at the Cosmos Club:

The following papers were presented:

Mr. C. W. Hayes.—'The Geological Relations of the Tennessee Brown Phosphate.' Three distinct types of phosphate rock occur in Tennessee, named from their prevailing colors white black and brown. The white rock is a recent cavern deposit; the black rock, including two varieties, nodular and bedded, is Devonian and the brown rock is Silurian. At four or more distinct horizons in the lower Silurian occur beds of phosphatic limestone, which, on the removal of the lime by leaching, yield high grade phosphate rock, containing from 70 to 80 per cent. of lime phosphate.

The recurrence of these phosphatic beds through so large a portion of the Silurian and Devonian formations points to a recurrence of similar conditions in Silurian and Devonian time favorable for the accumulation of lime phosphate. The deposits are at present located along the western margin of the central basin of Tennessee in a belt extending nearly across the State. This belt coincides with the western side of the Cincinnati anticline and a genetic connection between the two is suggested. This belt is characterized by numerous unconformities, in part by erosion, but chiefly by non-deposition. During Silurian and Devonian time it was doubtless a region of shallow seas protected from the incursion of foreign detrital sediments. Under these conditions the lime carbonate was perhaps removed by solution nearly as fast as deposited, and the lime phosphate which elsewhere is disseminated through a great mass of limestones was here concentrated into a relatively small volume.

Mr. Lester F. Ward.—'The Autochthonous or Allochthonous Origin of the Coal and Coal Plants of Central France.' Mr. Ward accompanied the excursions of the International Geological Congress to the coal basins of Commentry, Decazeville and Saint Etienne, and found this to be the principal geological problem presented. M. H. Fayol led the party through the two first-named basins, and lost no opportunity to demonstrate to the excursionists the validity of his well-known theory of deltas, according to which all the materials have been transported from the surrounding country and deposited in small lakes which have been thus gradually filled up. The excursion to St. Etienne was in charge of M. C. Grand'Eury, whose elaborate treatment of the 'Coal Flora of Central France' is familiar to all. He was not less zealous in seeking to make clear the autochthonous origin of the coal plants of that basin. Among the members of the party were Dr. I. C. White, M. H. Potonié and other competent judges of such questions. None of them had any *parti pris*, and all were open to the evidence, which, however, all admitted was in certain respects more or less defective. This was the fault of the conditions, and not at all of the able and courteous expounders of the respective theories. The result at least could not be positively stated in favor of either theory for all the beds, but M. Fayol may be said to have given a correct explanation of the mode of deposition of the Commentry basin and probably of most of that of Decazeville, although in the latter the underclays certainly hold the roots of plants. At St. Etienne M. Grand'Eury showed the party many cases in which the finest fibrils of the roots of erect Calamites were seen to pass across the planes of bedding and penetrate to the underlying conglomerates which formed the original floor; a condition which is wholly incompatible with the theory of transportation or the slightest disturbance of the plants.

Mr. E. E. Howell.—'A New Geological Relief Map of the United States.' This map, exhibited to the Society, is on a horizontal scale of about 40 miles to the inch, representing a portion of a globe 16½ feet in diameter. The vertical scale is eight miles to the inch. The geological data was obtained from the U. S. Geological Survey.

F. L. Ransome,
David White,
Secretaries.

CHEMICAL SOCIETY OF WASHINGTON.

A regular meeting was held October 11, 1900. The evening was devoted to the address of the retiring president Dr. H. N. Stokes, on the subject, 'The Revival of Organic Chemistry.' Science, October 12th.

A regular meeting was held November 8, 1900. The first paper of the evening was read by Mr. L. M. Tolman, and was entitled, 'The Examination of Jellies, Jams and Marmalades,' by L. M. Tolman, L. S. Munson and W. D. Bigelow. The paper gave the results of the examination of jellies and jams manufactured in the laboratory from 13 varieties of fruits. The solids, ash, acid, nitrogen, reducing sugar and cane sugar, were determined, and the amount of cane sugar inverted and calculated. The juices and pulps from which the samples were made were also examined. The relation between the acid content and the amount of cane sugar inverted was especially noted.

The second paper was read by Dr. Bigelow and was entitled, 'The Nitrogenous Compounds of Meat Extracts,' by W. D. Bigelow and R. Harcourt. The authors examined about fifty commercial extracts making use of the following methods: Precipitation by bromin as directed by Allen; precipitation by zinc sulphate; precipitation by ammonium sulphate; precipitation by bromin in filtrate from the zinc sulphate precipitate; precipitation by tannin and phosphotungstic acid (filtered separately), the latter precipitate being filtered at about 90° C., as directed by Mallet. The bromin precipitate from the original solution was found to hold only a small and variable portion of the proteids present. The zinc sulphate precipitate plus the bromin precipitate in the filtrate from the same gave results which were fairly satisfactory. The best results were obtained by use of the Mallet's method. Mixtures of digested egg albumin and purified meat bases were also subjected to the above methods.

William H. Krug,
Secretary.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

The section met on November 19th, Dr. A. A. Julien presiding. The following communications were presented:

'Recent Progress in Investigation of the Geology of the Adirondack Region,' by J. F. Kemp. Three classes of rocks are present in the area discussed: (1) those certainly igneous in their nature, including labradorite rocks, basic gabbros and trap dikes; (2) those certainly sedimentary, best illustrated by the crystalline limestones; (3) extensive areas of gneiss of uncertain origin. The distribution of the first class and the results obtained have been quite accurately ascertained by H. P. Cushing, C. H. Smyth and the speaker. The augite-syenite first discovered by Cushing near Loon Lake has since been found to be widely distributed in regions farther south. The ages of the trap dikes and their distribution were discussed.

Recent additions to the knowledge of the sedimentary rocks involve the recognition of quite large amounts of quartzites in a considerable number of new localities. Besides these, small beds of limestone have been discovered in the southern areas, especially in Warren and Washington counties, which are thoroughly interstratified with the gneisses and which leave no escape from concluding that the gneisses are also sedimentary in their origin and that a regularly stratified series of rocks is present. This conclusion removes many of the gneisses from the group of uncertainties.

The speaker enumerated the discovery of new outliers of Cambrian and Ordovician strata in the midst of the crystallines. He also noted the distribution of the glacial striations throughout the eastern mountains and their nearly uniform northeasterly bearing. The physiography is chiefly due to a series of faulted blocks which afford a very characteristic saw-toothed sky line.

'Notes on the Origin of the Pegmatites from Manhattan Island by A. A. Julien.

Dr. Julien, after discussing the prevailing theories of the origin of pegmatites, and showing that they did not adequately explain pegmatitic developments *in loco* in the districts mentioned, advanced the following conclusions:

1. The existence of at least two series of pegmatite developments, marked by a succession of intersections. Of these the oldest series is the most extensive, intercalated among the foliation-seams, and coincident with the strike. The later series cuts the schists in all directions and inclinations.

2. Every pegmatite occurrence on Manhat-

tan Island retains more or less structural evidence of having begun its existence as a vein, segregated from a magma or igneo-aqueous emulsion. Even the notable dike near 205th Street, crossing the dolomite, retains the vein structure, perfectly in places and imperfectly throughout.

3. Contact phenomena are confined mainly to the earlier alteration along seams, to projection of veinlets rather than intrusion pophyses, and, at one dolomite intersection, to a thin selvage of phlogopite and tremolite.

4. The vein structure presents distinct lamination, correspondent deposits on the two walls, comb structure, passage from less to more acid minerals toward the center, and final concentration of minerals of the rarer elements in association with the significant matrix, smoky quartz, along lenticular bands, often near a central suture.

5. Some of the most prominent features are the results of pressure upon the original veins through orogenic movements of the stratum of schists, viz., fissuring, faulting, crushing, shearing with development of aplite, refusion and development of new phenocrysts (granite-porphyry), and generation of reaction borders outside of each wall of a vein. Where flowage has taken place and some transferrence of the crushed vein material along the plane of the vein, the appearances of a dike begin. Many of these results may be distinguished along the course of the same vein at short intervals, but in the most characteristic dikes the vein structure is rarely, if ever, completely obliterated.

Theodore G. White,
Secretary.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A meeting of the Section was held at 12 West 31st Street, New York, on the evening of December 3, 1900.

Professor E. R. von Nardroff presented a paper with an experimental illustration, on 'The Determination of the Wave-Length of Sound by the Grating Method.' As a source of sound the author used a miniature steam whistle made of brass and operated by a current of air from a tank of compressed air. The sound produced in this way was inaudible on account of its high pitch, the wave length being only about three-eighths of an inch. The whistle was placed at one of the conjugate foci of a parabolic metallic mirror, a sensitive flame being placed at the other conjugate focus. A transmission grating made of wood, and resembling somewhat a portion of a picket fence, was then interposed in the path of the reflected sound waves, and it was found that when the sensitive flame was shifted to one side, as many as four positions of maximum effect were obtained on each side of the central direct beam of sound. With this apparatus, the wave-length of sound, when the waves were short like those used, could be measured to within one per cent.

Mr. W. G. Levison read a paper on 'A Method of Photographing the Entire Corona on One Plate,' employed at Newberry, S. C., for the total solar eclipse of May 28, 1900. The method consisted in the employment of a specially constructed color screen most dense at the center and fading off to clear glass at the edges, which was placed close to the photographic plate. The size and density of the screen were adjusted as nearly as possible so that the image of the inner corona made by a suitable lens fell on the part of the plate covered by the screen, while the image of the outer corona passed through the clear glass. The color screen was made from a lens of colored glass with sharp edges which was cemented into a recess in a plate of clear glass, ground to receive it. Two screens were made, one of orange-yellow glass and one of dark greenish-blue glass. In testing these screens at the time of the eclipse, an arrangement of telephoto-lenses was used, but unfortunately the exposure was not long enough to give any image at all of the outer corona through the clear glass, although a considerable impression of the inner corona was produced through the orange-yellow glass, but none through the bluish-green glass. This should give some idea of the relative actinometric intensity of the light from the inner and from the outer corona.

Mr. Levison also presented a short note on 'The Action of Canada Balsam on Photographic Plates.' In making the experiments with the color screens he noticed that Canada balsam that had been baked hard, when placed in contact with a sensitive plate, or separated from it by a layer of carefully selected black paper, and allowed to remain a week or more, affected the plate in the same manner as light, the part affected developing black. He verified this effect by a number of experiments. In the author's opinion this effect seemed likely to be caused by true Becquerel rays, as it passed through the black paper, which is perfectly opaque to ordinary light.

William S. Day,
Sec'y of Section.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The regular meeting of the Section was held on Friday evening, December 7th, at the Chemists' Club, 108 West Fifty-fifth Street, Dr. C. A. Doremus presiding.

Special invitations had been sent out to those interested in public water supply, as the feature of the meeting was an address by Professor William P. Mason, of the Rensselaer Polytechnic Institute, Troy, entitled, 'The Water Supplies of the Cities on the Mediterranean,' with lantern illustrations.

The address began with a description of Gibraltar, and its peculiar arrangements for water supply. From there to Tunis and other cities on the south shore, including the site of ancient Carthage ; then to Naples and Rome.

The system at Naples, once so primitive and unsanitary, is now on a scale and of a character to command admiration.

The typhoid epidemic at Hamburg in 1892 was alluded to, and a 'spot' map gave a graphic representation of the severity of the scourge in Hamburg, and the comparative immunity of the adjoining town of Altona, which, while having a separate water supply, was not more separated from Hamburg than Harlem from the rest of New York City.

A still more remarkable fact emphasized the value of filtration. The water supply of Altona was taken from below the sewers of Hamburg, passing through sand filters before distribution.

At the close of the address a vote of thanks was passed, and some routine business attended to. Four representatives in the council were elected, and a committee of three was appointed to confer with the Bureau of Combustibles in regard to the present existing restrictions as to storage of nitric, hydrochloric, and sulphuric acid.

Messrs. T. J. Parker, A. P. Hallock and William McMurtrie were appointed on this committee.

The situation, as it now stands, is such that a permit can be obtained for 1,000 pounds only of the acids named, whereas many establishments are using more than this amount every 24 hours, and, aside from the difficulty of having the acids delivered each day, any interference with daily delivery would result in suspension of large and important industries.

Durand Woodman,
Secretary.

THE NEBRASKA ACADEMY OF SCIENCES.

The Academy held its eleventh annual meeting in Lincoln at the University of Nebraska, on Friday, November 30th and on Saturday, December 1st. This was without doubt the most important as well as the most interesting meeting the Academy has ever held. The number of papers presented (as well as their subject matter) was especially noticeable for its high character. The meeting was called to order and presided over by President H. Gifford, who took for his address 'A Possible Explanation of the Shape of the Human Auricle.' This address was illustrated by well selected figures on charts and photographs, showing the external ear as found in a number of different types of animals both terrestrial and aquatic. In his treatment of the subject, Dr. Gifford called attention to the presence of a number of small muscles in the ear as found in these animals and indicated their influence in bringing about the prevailing form of this organ as found in man.

Professor Haven Metcalf presented a very interesting paper on 'Problems relating to the Individuality of Chromosomes,' which was discussed by Professors Duncanson, Metcalf and Ward. In this paper certain characteristics of these bodies were cited as explanatory of the possible ancestry of different hybrid plants.

Another paper that attracted an unusual amount of attention was that of Professor E. H.

Barbour on 'Sand-lime Crystals.' This latter paper was certainly an important contribution to the subject of crystallography, and will be received by geologists as a permanent contribution to the subject. Immediately following this paper some time was spent by Robert E. Moritz in presenting a discussion on the 'Extension of the Differential Processes' in a manner approved of by the mathematicians in attendance. Robert H. Wolcott then read by title a rather technical paper entitled 'A Review of the Genera of Water Mites,' in which the auther critically reviewed all the former attempts at the classification of these animals. He also suggested in that paper a more natural scheme of classification based on the derivation of the different forms aside from their chance present external resemblances.

Another paper of .more than ordinary interest was that of Professor William Hastings, entitled 'The Nebraska Type or Norm for each School Age, and Vitality Coefficients.' 'Thunder Storms' was the title of a paper by J. H. Spencer, in which the author gave a very concise description of what constitutes such a storm, its cause, method of development, extent, importance, and the comparative annual number of such storms for the State of Nebraska and surrounding regions.

The feature of the evening session was the presentation of papers of a more general nature. Some of these were 'Notes on the Occurrence of Asparagus Rust in Nebraska,' by J. L. Sheldon; 'The Determination of the Longitude of the University of Nebraska Observatory,' by G. D. Swezey; 'A Report on the Morrill Geological Expedition for 1900,' by E. H. Barbour; 'Additional Observations on Plant Movements,' Wm. Cleburne; a paper on the 'Delimitation of the Field of Pedagogy,' by W. A. Clark, and one on 'Degeneracy,' by Dr. H. B. Lowry. In his presentation of this latter subject the doctor dealt chiefly with the criminal phase. It is needless to state that this paper will form very interesting reading when published.

The papers presented at the session on the morning of December 1st were 'The Geology of Saunders, Lancaster and Gage Counties,' by C. A. Fisher; 'North American Bees of the Genus *Agapostemon*,' by J. C. Crawford, Jr.; 'The Work of the State Geological Survey during the Summer of 1900,' 'Bone Tissue, Recent and Fossilized,' and one on the 'Extent of the Fiberous Arikaree Beds,' by E. H. Barbour; 'Some Tests of Camera Shutters,' G. D. Swezey; 'Notes on Beet Diseases in Nebraska,' Geo. G. Hedgecock; 'A Brief Account of some Rare Alaskan Worms,' H. B. Ward; 'Observations on Species of Nebraska Water Mites,' Robert H. Wolcott; 'Report on the Botanical Survey of Nebraska,' Roscoe Pound; 'Additions to the List of Nebraska Fossils,' Carrie A. Barbour, and 'Some Impressions of Biological Conditions in Arizona,' A. A. Tyler. As nearly all these papers were more or less technical in their nature, or of minor general interest, they were presented by their authors in abstract.

The officers elected for the ensuing year are: Ellery W. Davis, President; J. H. Powers, Vice-President; Robert H. Wolcott, Secretary and Custodian; G. A. Loveland, Treasurer; Board of Directors: William Cleburne, C. H. Gordon, H. B. Lowry and L. Bruner.

On motion of the chairman of the committee on publication it was decided to publish at once the proceedings of the present meeting, also the proceedings of the last two meetings, which have been held in abeyance awaiting the publication of the report of the Nebraska Historical Society with which they are to appear.

A committee of three was also appointed to await upon the members of the coming legislature for the purpose of securing any possible State aid in the future publication of the Academy's proceedings.

LAWRENCE BRUNER,
Secretary.

DISCUSSION AND CORRESPONDENCE.

A GASOLINE LAUNCH FOR FIELD WORK.

TO THE EDITOR OF SCIENCE: Three years ago I published in your columns a few brief statements regarding the feasibility of using gasoline for motive power in conducting geological work in the Eastern United States, and more particularly in New York. Since then several long, and I may venture to say successful, excursions have been made. It is, however, to show the aid which power of this kind can give to regular university work in field geology that this communication is written.

The Cornell Summer School of Field Geology had for headquarters this season the classic region of Trenton Falls, N. Y., where collecting, section-making, map-making, etc., were carried on in great detail. At different times the two divisions of the class were taken by boat along the Erie Canal to Troy, and, by short railway trips to the Helderberg Mountains, the Cambrian east of Troy and to Oriskany Falls. The farthest north reached by boat was Plattsburg on Lake Champlain. During the summer the students had an opportunity to study the Archæan at several localities, also the Lower and Upper Cambrian, the Calciferous, Chazy, Birdseye, Black River, Trenton, Utica, Hudson River, Clinton, Onondaga, Water Lime, Lower Pentamerus, Delthyris shaly, Upper Pentamerus, Oriskany, Cauda-galli, Schoharie, Corniferous, Marcellus and Hamilton formations. Owing to boat accommodations, the class was limited to fifteen (four women and eleven men) though many more applications for admission to the class were made.

For the coming summer (1901) there will be room for forty-five. The Helderberg Mountains (Country man hill section) will be used as a rendezvous, where a camp will be formed similar to that of the past summer at Trenton Falls. This place has been selected because of the large number of formations (about a dozen) accessible within a radius of one mile. Excursions by boat down the Hudson to Rondout, up the Champlain to Valcour Island, westward on the Erie Canal to Syracuse, will be made without fail.

Many of the places visited could be reached by rail supplemented by hack drives, but I venture to say not so economically for the student. By camping and cooperation in the work, no one need spend over $65 for a ten-week term. This includes tuition, board and everything, and is the result of experience and not a mere estimate. Compare these figures with estimates of expenses as usually given in announcements for summer schools of field geology (usually for six weeks only) and observe the difference. Special attention is called to this fact, for it has often seemed to the writer that not enough consideration is usually given to the class of students who would profit most by opportunities for field work.

That the most advantageous place to study geology is in the field is too obvious to need any explanation here. The drawback in such work is the expense. In a recent English publication we read: "Would that some munificent person would found in the basin of the river Ribble a geological station where Cambridge students would have the means of acquiring a knowledge of field geology under conditions more favorable than those presented by the flats around the sluggish Cam."* The points of special note in our method of work, with the Helderbergs as a center of operation, are the following: (1) The mountains were long ago recognized by the illustrious Lyell and others as most ideal for geological study. (2) By camping and cooperating in camp duties we can make fair progress without the 'munificent person' so often appealed to. (3) By making long excursions by boat in various directions a far broader view of geology can be obtained than by remaining all the time at one station, however well it may be equipped, or however well located. (4) The more advanced student can keep his eyes open and ask the party to stop and stay at localities affording new materials so long as seems advisable.† There is no hurrying to catch trains and no fear of the oncoming of the night. Original work can accordingly be done to great advantage, serving not only to advance our knowledge of geological science, but also to demonstrate to the less advanced students the meaning of real geological work.

Gilbert D. Harris.
Cornell University,
December 8, 1900.

CURRENT NOTES ON METEOROLOGY.

DE SAUSSURE'S ESSAYS ON HYGROMETRY.

No. 115 of Ostwald's 'Klassiker der exacten Wissenschaften,' is a German translation of de Saussure's 'Essais sur l'hygrométrie,' which

* 'The Principles of Stratigraphic Geology,' by J. E. Marr, 1898, p. 98.

† See *Bull. Amer. Paleont.*, No. 13, November, 1900.

were originally published at Neufchâtel in 1783. This useful series of reprints also contains two other volumes of distinctly meteorological interest, viz., No. 57, 'Fahrenheit, Réaumur, Celsius, Abhandlungen über Thermometrie. 1724, 1730–1733, 1742,' and No. 58, 'Otto von Guericke's neue Magdeburgische Versuche über den leeren Raum., 1672.' The work of de Saussure in connection with hygrometry was of marked importance, and it is well to have interest in it revived by means of this attractive little volume, the price of which is but 2 m. 60 Pf. The book contains a brief biographical sketch of de Saussure, and also a number of notes on the text. The publisher is Engelmann, of Leipzig.

BRITISH RAINFALL FOR 1899.

THE fortieth volume of 'Symons's British Rainfall,' that for the year 1899, is the first one of the long series of these annual reports which has been compiled by anyone but Mr. Symons himself. Owing to the death of the founder of the British Rainfall service on March 10, 1900, the duty of compiling the annual report has devolved upon Mr. H. S. Wallis, who was associated with Mr. Symons for 30 years. 'British Rainfall' for 1899 appropriately contains an appreciative notice of Mr. Symons's life and work, together with an excellent portrait of that distinguished meteorologist. The number of observers from whom records are received is now about 3,500. Besides the usual full presentation of the results of the year's observations, the present volume contains a discussion of the average rainfall of the decade 1890–99, as determined by records at a hundred stations well distributed over England, Scotland and Ireland.

SCIENTIFIC BALLOON VOYAGES.

NOTICE has been received of a new work on balloon meteorology, issued by Friedr. Vieweg und Sohn, Braunschweig. The title of the work is 'Wissenschaftliche Luftfahrten, ausgeführt vom Deutschen Verein zur Förderung der Luftschiffahrt in Berlin.' The authors are Drs. Assmann and Berson, and associated with them are the following well-known meteorologists or aëronauts: Baschin, von Bezold, Börnstein, Gross, Kremser, Stade and Süring. There are three volumes. The first deals with the history of balloon ascents and with the instruments and their use; the second contains accounts of individual ascents, and the meteorological results obtained on them, and the third volume summarizes the whole subject, giving the most important results. The price of the work is 100 Marks.

R. DEC. WARD.

YELLOW FEVER AND MOSQUITOES.

MEDICAL authorities are by no means agreed as to the value of the experiments on the relations between yellow fever and mosquitoes carried out at Havana by Drs. Reed, Carroll, Agramonte and Lazear. The *British Medical Journal* remarks editorially: "At first glance these experiments appear to show almost conclusively that the germ of yellow fever is conveyed by a special species of mosquito — *Culex fasciatus*, presumably—and that the insect becomes infective only after from ten to thirteen days from the time of ingestion of the germ. Unfortunately the mode in which the experiments were conducted detracts much from their value. They are really by no means conclusive. The experimenters themselves are of this opinion. At most they are suggestive. It is to be regretted that, considering the great danger to which the subjects of these experiments were exposed, greater care was not exercised that the conditions of the experiments were absolutely free from objection. If life was to be risked, it was surely imperative that this risk should not be incurred in vain; that it should be unnecessary to go over the ground afresh, and thereby entail further risk.

Manifest objections to the conclusion that the mosquito did convey the disease in the three cases which yielded a positive result are, first, that nine out of the twelve individuals subjected to mosquito bite did not contract yellow fever; secondly, that those individuals who did contract the disease had entered the local endemic yellow fever area about the time they were bitten; they might have contracted the disease in the ordinary way, therefore, and not from the experimental mosquitoes; thirdly, that the germ of yellow fever has been recognized neither in the mosquito nor in human blood.

Dr. Lazear's life has not been altogether thrown away if these experiments lead, as they must, to their repetition under more rigid conditions, and if it be found that yellow fever is conveyed by the mosquito, the important sanitary measures which will result from the discovery will atone, in a measure, for the regrettable sacrifice. Meanwhile the bacillus icteroides of Sanarelli is being discredited, and, like so many of its predecessors, may have to give place to some other microorganism, in this case, possibly, of a protozoal nature.

UNINSULATED CONDUCTORS AND SCIENTIFIC INSTRUMENTS.

In his inaugural address as president of the British Institution of Electrical Engineers delivered on November 8th, and published in *Nature*, Professor John Perry urged the importance of scientific and mathematical training for electrical engineers. He said: "In this address I mean to put before you this simple question: Is electrical engineering to remain a profession or is it to become a trade? Is this Institution to continue to be a society for the advancement of knowledge in the applications of scientific principles to electrical industries, or is it to become a mere trades union?"

Professor Perry, in the course of his address referred to the use of insulated return conductors in connection with electrical transportation, where uninsulated conductors may disturb scientific instruments, saying:

"At Potsdam this sacrilege has been forbidden. At Washington, Toronto, Capetown and most other important places, the magnetic records have already been rendered useless. Professor Rücker and I were asked by the other members of the Committee of the Royal Society which was in charge of the Kew Observatory to defend Kew, and with the help of her Majesty's Treasury we thought we were able to insist upon the use of insulated returns in all undertakings authorized by Parliament where harm was likely to be inflicted on Government observatories. * * * We were, however, mistaken, for the only clause which we have been able to get inserted in all Parliamentary authorizations of undertakings leaves it to the Board of Trade to substitute other methods of protection than the insulation of the return conductors in cases where these other methods seem to be sufficiently good for the protection of laboratories and observatories, and this is why the Board of Trade appointed the committee which met on October 31st, probably for the last time. * * * I beg to assure you that I have been acting in your best interests. As an electrical engineer I ought surely to regret the use of uninsulated returns, even if we leave Kew Observatory out of account. Suppose we do not now insulate our returns. Electricity will certainly return by gas and water pipes and the amount of harm done to those pipes is merely a question of time. Because of the ignorance of legislators and gas and water companies, nothing is said just now; but will nothing be said at the end of ten or twenty years, when pipes are found to be eaten away everywhere? And if by a slight increase of expense, or rather, as I think, actually no increase of expense, but merely a little increase in inventiveness and common sense on the part of electrical engineers, this evil may be entirely prevented, surely it is in the interests of all of us that insulated returns should be insisted upon. But even if we do not insist on insulating the returns in all systems, surely something may be said for the giving of this protection on lines near such a magnetic observatory as Kew. Even the magnetograph records now being made have been continuous for forty five years, and if Kew is interfered with no sum of money can compensate for the interference; for if the observatory were removed the future observations would have no link with the past."

SCIENTIFIC NOTES AND NEWS.

The programs of the scientific societies in session during Christmas week at Baltimore, Chicago, New York and Albany show that an interesting series of meeting will be held. We hope to publish in early issues the official addresses and discussions, together with accouuts of the meetings.

Dr. G. A. Miller, of the mathematical department of Cornell University, has just been awarded the prize of $260 offered by the Royal Academy of Sciences of Cracow, for researches in the theory of groups.

PROFESSOR W. G. JOHNSON, state entomologist at the Maryland Agricultural College, has resigned to become editor of the *American Agriculturist.*

DR. PETER M. WISE has been removed from his office as president of the State Commission in Lunacy by Governor Roosevelt on the charge of soliciting subscription to a mining company of which he was president from his official subordinates. It will be remembered that Dr. Wise was largely instrumental in the curtailment of the work of the New York State Pathological Institute.

DR. JOHN J. ABEL, professor of pharmacology in the Johns Hopkins University, was injured in an explosion in his laboratory on December 19th. He was taken to the Johns Hopkins Hospital and it is feared that his eyesight may be injured.

PROFESSORS J. W. TYRELL and J. W. BELL, of the Canadian Geological Survey, have returned to Vancouver, after an expedition extending 5,000 miles through the Barren Lands of northern Canada. The party is said to have secured much valuable geological and other scientific information.

ON December 20th, Dr. George Bruce Halsted and Professor Wm. M. Wheeler started from Austin on an expedition into southern Mexico. Professor Wheeler will collect and study Mexican ants. Dr. Halsted is interested in the anthropological exploration of 'La Mesa Cartujanos,' and will also be at Mitla.

THE Academy of Sciences of Vienna will send a botanical expedition to Brazil next year under the direction of Dr. Richard von Wettstein, director of the Botanical Garden of the University of Vienna, and Dr. Viktor Schiffner, professor in the German University at Prague.

OWING to the retirement of Mr. Charles Whitehead, F.L.S., F.Z.S., from the position of technical adviser to the Board of Agriculture, it has been arranged that the scientific and expert assistance required by the Board in connection with these subjects will be furnished respectively by the Royal Botanic Gardens, Kew, and by the Natural History Departments, South Kensington.

THE committee on the trust founded by the late Sir John Lawes for the purposes of scientific investigation and experiments in connection with agriculture held its first meeting since the death of its founder, when the following resolution was unanimously agreed to: "That the Lawes Agricultural Trust Committee desires to place upon record its deep sense of the irreparable loss it has sustained by the sad and unexpected death of Sir John Bennet Lawes, to whose munificence the trust owes its existence, and to whose wise counsels and hearty cooperation any success that may have attended the operations of the committee has been largely due."

THE Huxley Memorial Committee has just issued its final report and donation list. The total sum at the disposal of the committee was £3,405, 10s, 2d. The total cost of the statue, now in the Natural History Museum, London, was £1,813, 18s, 8d. The cost of preparing the Huxley gold medal, to be awarded by the Royal College of Science, was £263, 17s. The surplus of the fund being insufficient to provide a third object of memorial, as originally contemplated, the whole sum of £1,126, 6s, 4d. has been invested as an endowment for the medal. The committee has, however, arranged with the council of the Anthropological Institute to allow them the use of the obverse die, for the production of a presentation medal, of which that body will provide the reverse die and impression, in commemoration of Huxley's labors as an anthropologist. The committee also recalls the generous action of the Hon. J. Collier in painting a portrait of Huxley and presenting it to the National Portrait Gallery. The list of subscribers contains about 750 names, without reckoning individually the many who subscribed through local societies and committees.

DR. J. BOERLAGE, assistant director of the Botanical Garden in Buitenzorg died recently while on a scientific expedition to Ternate.

THE death is announced of Dr. G. Hartlaub, the eminent German ornithologist, at the age of eighty-seven years.

DR. A. W. MOMERIE, formerly professor of logic and metaphysics in King's College, London, and the author of numerous books on philosophical and theological subjects, died on December 6th at the age of 52 years.

We regret also to record the deaths of the following men of science: Dr. Theodor Adensamer, assistant in the Natural History Museum in Vienna; Dr. August Böttcher, physicist in Berlin; Dr. Adolf Stengel, professor of Agriculture in the University at Heidelberg, and Father Amand Davis, corresponding member of the Paris Academy of Sciences in the section of geography.

It will be remembered that the late Professor Hughes left £4,000 to the Royal Society for the establishment of a prize. The Society has now decided to award annually a gold medal, to be called the Hughes Medal, not exceeding in value the sum of £20, together with the balance of the income, to such person as the president and council may consider the most worthy recipient, without restriction of sex or nationality, for original discovery in the physical sciences, particularly in electricity and magnetism.

At the banquet of the Royal Society on November 30th the Swedish and Norwegian Minister, in replying to a toast, said that the prizes to be awarded by each of the five Noble institutes would amount to about £8,000 annually.

The Committee of the National Educational Association charged with selecting the place of meeting for the year 1901 has voted in favor of Detroit. The meeting will be held in July. The Association met at Detroit in 1874.

A science club has been organized in Las Vegas, New Mexico. At the first meeting held early in December, Mrs. Wilmatte P. Cockerell referred to the tendency of the butterfly *Argynnis nitocri* to develop distinct races on isolated mountain ranges, and exhibited a new race from Sapello Cañon, N. M., which it was proposed to call var. *nigrocærulea*. Mr. Emerson Atkins exhibited some rodents which he had collected in the mountains near Las Vegas, including specimens of *Sciurus fremonti*, which appear to indicate that the subsp. *neomexicanus* of Allen could not be maintained, but must be referred to subsp. *mogollonensis*. He also showed examples of a *Tamias* which served to connect *T. quadrivittatus*, Say., with *T. cinereicollis*, Allen, indicating that the latter should apparently be regarded as a subspecies of the former. Mr. T. D. A. Cockerell exhibited and discussed some parasites found in the nest of the bee *Anthophora occidentalis*, Cresson, at Las Vegas. These included the metoid beetles *Leonidia neomexicana* (Ckll.) and *Meloe sublævis*, Lec., the former only known heretofore by a single example, and the chalcidid *Monodontomerus montivagus*, Ashm.

Professor F. H. Herrick has been invited to give a lecture on 'The Habits and Instincts of Wild Birds' at Trinity, before the Hartford Scientific Society on January 15th. He will give the same lecture at Yale University, before the Scientific Society of Sigma Xi, on January 17th; at Brown University, before the Rhode Island Audubon Society, on January 17th, and at Dartmouth College on January 18th.

The Hungarian Minister of Education recommends the appropriation of 332,000 crowns for the establishment of a general pathological institute together with a Pasteur institute at Buda-Pesth.

Drs. Sambon and Low have returned to England, after the summer spent in the mosquito-proof hut in the Roman Campagna. They are in excellent health, though it is said that the past summer was exceptionally malarious. For example, fifteen or sixteen police agents were sent to Ostia, and though they only remained a night in the place, they all developed fever.

A cable dispatch to the New York *Sun* states that investigations of the causation of yellow fever now being carried on at Marinao have so far confirmed the report of the Surgeon-General's commission. Five soldiers who have kept themselves protected from mosquitoes have been living in infected clothes and sleeping in infected beds for twenty days and have not yet developed any symptoms of the disease.

At its annual meeting on December 14th the American Forestry Association recommended that a national park be established in Minnesota and that the California big trees be preserved so far as possible.

We learn from the London *Times* that very striking evidence of the shriuking up of Lake Tanganyika was furnished in the paper read recently in Brussels by Captain Hecq, who stated that the post of Karema, founded 20 years ago on the shores of the lake, was now fourteen miles distant from the lake. Captain Hecq also recently visited Lake Kivu, the waters of which are so salt that neither crocodiles nor hippopotami are to be found in it. This lake is given the appearance of being divided into two by a large island, and this may explain some generally accepted errors which are now being definitely solved by a German-Congolese boundary commission.

A resolution has been adopted unanimously by the French Chamber of Deputies calling upon the government to prohibit the manufacture and sale of all alcoholic liquors pronounced 'dangerous' by the Academy of Medicine. The resolution is especially concerned with the consumption of absinthe, which continues to increase in France.

The Buffalo Society of Natural Sciences expects to cooperate with the New York State Museum in making an exhibit at the Pan-American Exposition, at Buffalo, in 1901. This exhibit will be held in the New York State building. An especially fine collection from the water-line rocks near Buffalo, consisting of the fossil crustaceans—*Pterygotus*, *Eurypterus*, and *Ceratiocani* will be shown. This collection is being mounted for exhibition at the State Museum.

The London *Times* states that in view of the fact that the Royal Institution of Civil Engineers has, by a decision of the House of Lords, been exempted from payment of the Corporation Tax (1894), it is submitted that the Royal Colleges of Physicians in London and Edinburgh may reasonably claim similar treatment; and an attempt is being made by Sir John Tuke to induce the Chancellor of the Exchequer to concur in this view. The especial hardship in this case is that, notwithstanding the important part played by the two colleges in administering and regulating medical education and examination, and in maintaining laboratories for original research, and the obligation upon each fellow to pay a stamp duty of £25 on election, there will be five years of arrears to make up if the authorities persist in their intention to levy the tax.

We learn from the *Electrical World* that the International Conference sitting in Brussels for the Protection of Industrial Property, at which United States Assistant Patent Commissioner, Walter H. Chamberlin, and Lawrence Townsend, United States Minister to Belgium, were the American representatives, adopted the following resolutions: First—The period of exclusive rights, previously fixed at six months for [applications for] patents and three months for industrial designs, models and trade marks, is extended to a year for the first named and four months for the second named. Second—Countries signing the convention enjoy reciprocally the protection accorded by each country to its own citizens against unfair competition. Third—Patents cannot lapse because they are not put in circulation, except after a minimum delay of three years, dating from the first application in countries where the patent is allowed and in cases in which the couditions of the patent do not justify causes of inaction.

At a meeting of the Zoological Society of London, on December 4th, Mr. J. S. Budgett read a paper on 'The Breeding-habits of *Protopterus*, *Gymnarchus*, and some other West-African Fishes,' in which an account was given of a collecting-trip made during last summer to the swamps of the Gambia river in search of the eggs of *Polypterus*. The eggs of *Polypterus* were not discovered, though a very young specimen measuring only one inch and a quarter in length was found. In this small specimen the dermal bones were not developed, and the external gills were of very great size, the base of the shaft being situated immediately behind the spiracle. The dorsal finlets formed a continuous dorsal fin. The secretary read an extract from a letter which had been addressed to the Colonial Office by the West India Committee, concerning the proposed introduction of the English Starling or the Indian Mynah into St. Kitts, West Indies, to check the increase of grasshoppers, which were causing great damage to the growing crops of that island.

UNIVERSITY AND EDUCATIONAL NEWS.

At the convocation exercises of the University of Chicago on December 18th President Harper announced that Mr. John D. Rockefeller had made a further gift of $1,500,000 to the institution. Of this sum $1,000,000 is to be used as an endowment fund. The balance of the gift is to be used for general needs. Mr. Rockefeller suggests that $100,000 be used for the construction of a university press building. Mr. Leon Mandel has given $25,000 to the university in addition to his previous gifts.

It is said that Brown University has received gifts of $25,000 and $10,000 towards the second million dollars for the university endowment.

An anonymous friend of the University of Pennsylvania has given a fund for prizes in the School of Biology and in the department of interior decoration in the School of Architecture. The annual value of the prizes will be $400 in the School of Biology and $150 in the School of Architecture.

We are glad to learn that the validity of the will of the late Colonel Joseph M. Bennett, of Philadelphia, making a large bequest to the University of Pennsylvania has been sustained, the Court refusing to send the case for trial by jury.

At the annual meeting of trustees of the University of Illinois, at Champaign, the board decided to ask a total appropriation of $900,000 from the Legislature, $90,000 of which is to be used to build a new workshop in place of the one destroyed by fire ; $150,000 for the chemical building and $100,000 for a women's dormitory. The remainder will be used for current expenses for the next two years, including $15,000 a year for the library, and $16,000 a year for the establishment of a School of Social and Political Science.

Lord Strathcona was installed as Lord Rector of Aberdeen University on December 18th. At the close of his address he announced that he would give £25,000, provided £50,000 more was raised within a year, to wipe out the debt of the university. Charles Mitchell, of Newcastle, has offered to subscribe £20,000.

Herr H. Huber has bequeathed 50,000 fr. to the Polytechnic Institute at Zurich to be used for scientific excursions.

The Executive Committee of the Board of Trustees of Cornell University has awarded the contract for the use of the medical department on the campus at Ithaca. The building will cost $125,000 and will be ready for use in the autumn of 1902.

At a stated meeting of the Board of Trustees of the University of Pennsylvania, held December 4th, Dr. Edgar F. Smith, professor of chemistry, who has been acting vice-provost for some time, was elected vice-provost. Charles Hugh Shaw, Ph.D. (Penna., 1900), professor of biology in the Temple College, Philadelphia, was elected to an honorary fellowship in botany, in order that he may continue the research work in cytology which he had undertaken while pursuing his graduate work.

President Butler, of Colby University, has resigned and will accept a chair at the University of Chicago.

Attention was called in the last issue of Science to the fact that Professor T. S. Townsend, of Trinity College, Dublin, and Cambridge University, had been appointed to the newly-established Wykeham professorship at Oxford. The abilities of Mr. Townsend are fully recognized, and it is expected that he will place the teaching of electricity on a satisfactory footing at Oxford, yet some dissatisfaction is expressed that an Oxford man should not have been elected. Oxford scientific men get professorships elsewhere, but to judge from the list of professors, they are without honor in their own country. This is thought to be a discouragement to science at Oxford. In the present case, however, the complainants can scarcely point to an Oxford electrician suitable for the post.

At a meeting of the Royal Institution on December 3d, it was announced that Dr. Allan Macfadyen had been elected Fullerian professor of physiology.

Dr. Josef Hort has, owing to ill health, retired from his professorship in the Technical Institute at Karlsruhe.

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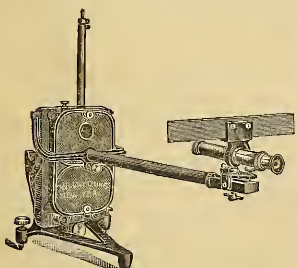

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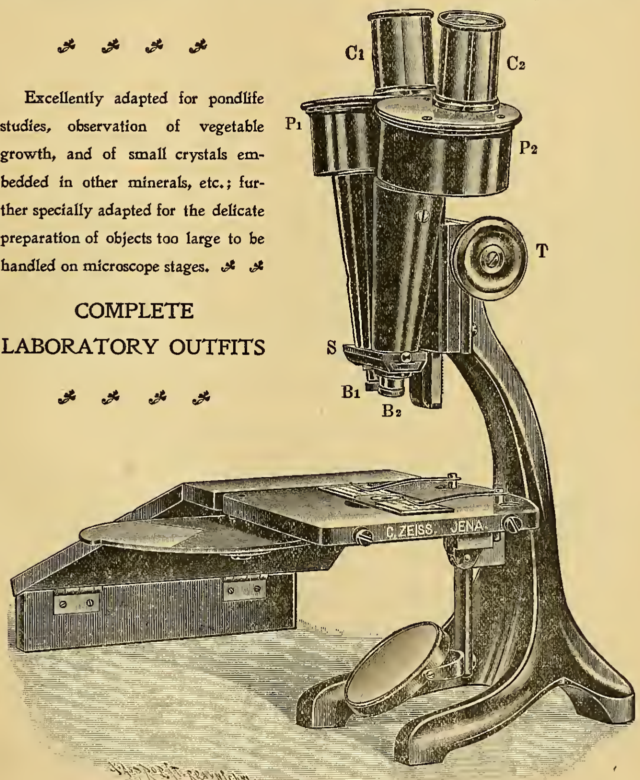

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